Action schemata in professional activities. The use of existing schemata and their role in the construction of new schemata in the context of administrative tasks

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ACTION SCHEMATA IN PROFESSIONAL ACTIVITIES
The use of existing schemata and their role in the construction of new schemata in the context of administrative tasks

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Appendix 9

Building a new schema from known schemata

Make a new file

1. Préparer the contract:

This is a special form which consists of a printed first page specifying contract status. This page is duplicated three times . Fill it out

- note all data:
  - the person's details: name, date of birth, profession, bank account n°, etc.
  - all data concerning the contract
- and later the contract will be signed

2. Prepare a small file for the tenant with all information concerning the apartment

- take the small file of the apartment in the file cabinet
- make photocopies
  . extra charges
  . plans of the apartment etc....
- put them together into an envelope.

3. Get the contract signed

- when the person comes, ask for signature
- give him one copy
- keep 2 copies
- file one
- send one other to the accounts department

UNUSUAL TASK PROPOSED TO THE SUBJECT

Deal with all travel arrangements for persons going on business trips

*** Reserve a car in France**

- call the car hire company
- fill out the special form (with 4 pages)
- estimate costs and make a remark (no public transport or no easy transport)
- file one page in chronological file
- give the others to the person (put them with the other documents in a envelope temporarily)

*** Receive a ticket**

- check the ticket and the invoice
- file the invoice
- open an envelope with the person's name
- put in everything concerning the trip
- if necessary a special form concerning foreign currency
- or the special form for car hire
- file the envelope temporarily
- range the file by date of departure

*** Edit and print authorization of the trip**

- request print out for the authorization of the trip (5 copies)
- give one copy to the person concerned with the ticket; temporarily keep it in the file (in the envelope with the ticket etc.)
- keep 2 copies, one in the person's file and the other in chronolochical "symposium"
- send off one copy to management and to the personnel department.

USUAL TASKS CARRIED OUT BY THE SUBJECT (described during the interview).

Subject 11

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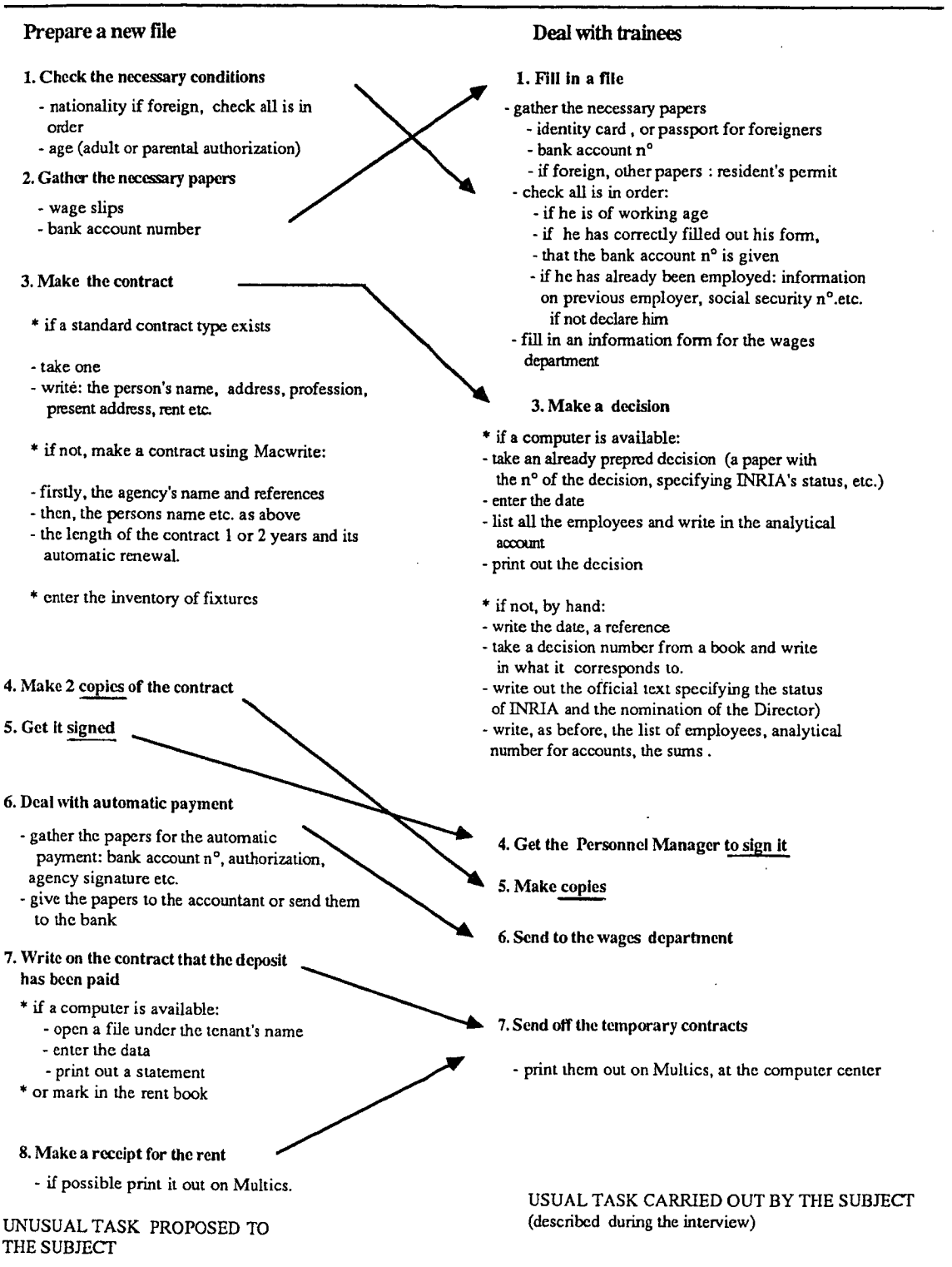
Appendix 8

Use of a known schema



Subject 8

Appendix E.5.5

Use of computer system to make the summaries: comparison of subjects' representations (extracts)

Procedures planned during the experiment	**Procedures generally used by the subjects**
(Subject 8) * Using computer system : - take a speadsheet - enter the data: rent, charges - print out a statement - complete it with the deposit.	*(Subject 8) Do the bonuses* "We change what has to be changed: In the Mac it's presented like this: It's a table with - name, first name, n° of employee, code... - after each month: the total *Vacation statement: create employee's file* - enter the data - specify the months - each months, print out the vacation statements
(Subject 13) Using the Macintosh. - call the tenant's file - take a spreadsheet (Excel or Multiplan) - fill in the columns - print out the table	*(Subject 13) Update the accounts* - bring everything together (order forms, invoices etc.) - summarize in the tables - use the Emac editor - load the spreadsheet - fill in the figures and the data - print out
(Subject 11) Using a computer system - print out a ready-prepared table and complete it.	*(Subject 11) Edit and print fund allocation* - complete the information given by the terminal .

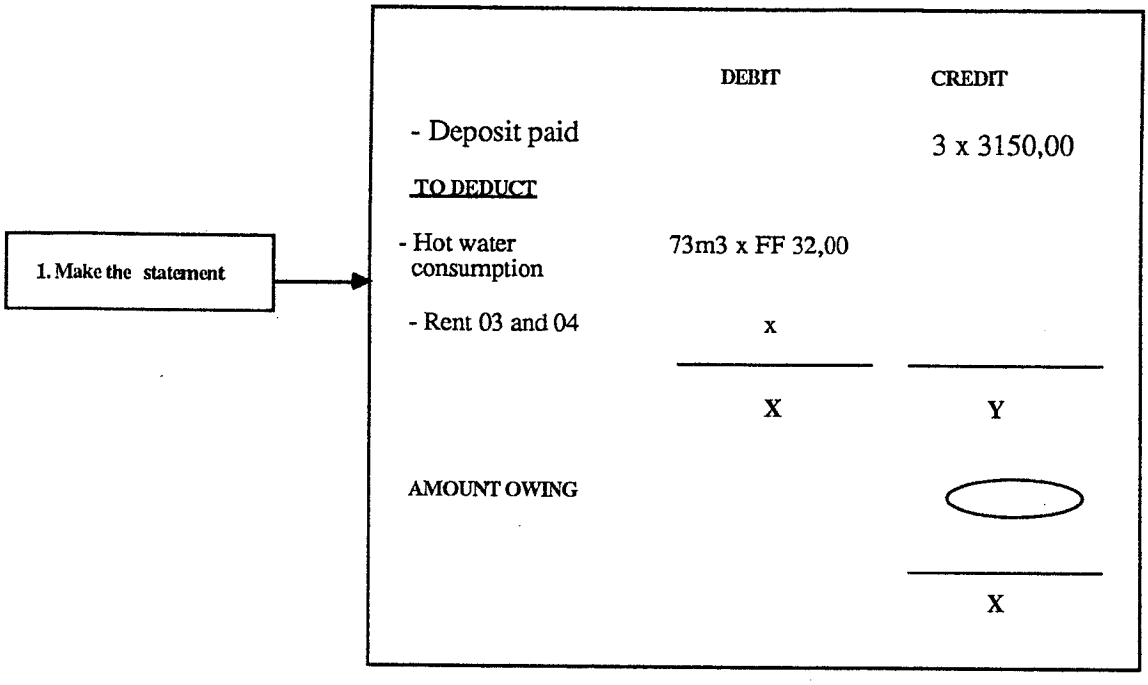
Appendix E.5.4

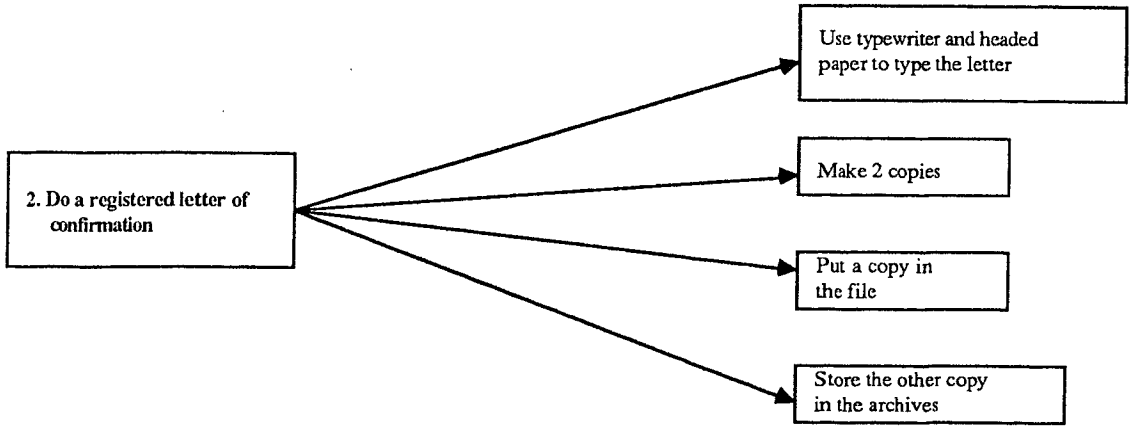
Draw up the summary table: comparisons of the subjects' representations (extracts)

Procedures generally used by the subjects	**Procedures planned by the subjects during the experiment**
Summary table for budget accounts (Subject 1) - take all the budget accounts - write in the provisional budget - make the modifications - calculate the credit - draw up available assets	*(Subject 1)* * make 4 columns - basic rent - deposit (3 month) - hot water (FF32X73m3) - amount owing
Type scientific articles using ETAP (Subject 3) * For the tables - use the "Table" software - edit the table and set up the page: - load program - name file - make the margins - type in the table - enter the data - insert the table in the correct place	*(Subject 3)* * Make the table using ETAP - call up the "Table" software - edit the table - give the mesurements - give number of lines - give number of columns - name the table "rent".. - enter the headings in the table - rows : rents for March and April, charges, deposit . - columns : debit/credit - fill in the amounts: total, under debit: enter the rents and charges, under credit : the deposit.

Appendix E.5.3

Summary of Mr.A's accounts: (Control subject)
Drawing up the table and representation of the task





Appendix E.5.2

Summary of Mr. A's accounts:
(Explanation by control subject)

1. Do the accounts

- make DEBIT, CREDIT (2 columns)
- deposit paid: 3 X 3150.00 (in the credit column)
- TO DEDUCT
 - Hot water consumption 73 m3 X FF.32.00
 - rent for March and April (03 and 04) : x
- thus, a total of X here, and Y there
- AMOUNT OWING: a sum (under Y = X)

(Specify that certain things will be in bold type.)

2. Do a registered letter of confirmation (even if he is coming)

- do a letter on headed paper using the typewriter:
"Following the audit of your account, we inform you that ... on (date of the letter) your account with us is outstanding to the sum of ..., this sum being the total of: ... (give details).
We would ask you to effect payment within 8 days and inform you that failure to do so will result in legal action being taken....."

- make 2 copies
- put one copy in the file
- file the other in the archives

Appendix E.5.1

Summarize Mr.A's accounts: Quantitative table of the procedures planned by the subjects.

Create a summary table - one attempt (8 subjects) - two attempts (4 subjects) - three or 4 four attempts (3 subjects)	n = 15
An explanatory letter	n = 1
An accompanying letter	n = 8
Other actions : (Balance and check the accounts and send to the bailiff).	n = 5

Appendix E.4.5

Register the cheques : comparisons of the subjects' representations (extracts)

Procedures generally used by the subjects	**Procedures planned by the subjects during the experiment**
Update contracts (Subject 6) - call up the summary - make the modifications (according to the negociations) - print out the new document: - destroy the old document - put the new one in its place	*Record on the system (Subject 6)* - call up the person's file - enter the data - each month print out a daily statement to make the report
Update legal commitments (Subject 1) 1) Make a basic table using the Macintosh: - make a frame (EXCEL software) - take the first budget with the budget codes - write in the figures for each account 2) Make the modifications - always use the same table - note or change the figures	*Check that the sum is correct (Subject 1)* - use the Macintosh - call up the owner's or the tenant's file Prerequisite: the table must exist already, if not: - make a table - write in the name of the person, the amount of the monthly rent or the charges - write in what he pays each month - and the amount owing or if all has been paid
Make the statistics for the tutorials (Subject 4) - make a summary table - find information for each tutorial in the files - note them	*Record for the accounts (Subject 4)* - take the summary table from the "client" file (to see what he must pay and how much he owes) - note the day of payment , the sending of the cheque, the sum under each heading (rent or charge)
Diffuse a new version of X.. (Subject 12) - ... - Follow up the diffusion: - check that it has been done - send reminders *Make a provisional order (Subject 12)* - ... - follow the progression of the file - check that it has been received - ..	*Later, after receiving the bank statement (Subject 12)* - check that the cheques have been paid in.

Appendix E.4.4

Register the cheques : comparison with the subject's known procedures (subject 2)

	Deal with charges in grade
	- .... - Send the decisions to financial supervisor for signing :
* Make 2 summary forms (one for the bank, one for Post Office Accounts) - take a printed form - calculate in the total - write out the sum in full	- make a dispatch form - take a printed form - fill it out
* keep photocopies	- keep a photocopy
* file them	- file it in the chronological file
	Make a certificate
1) in the general accounts file 2) in the sub-file "rents" or "charges" payment	- .... - make photocopies - file them 1) in the chronological file 2) one in the file
(a) a printed form can be: - printed by the bank or the post office - or drawn up at the agency with a Macintosh or another computer system	**Use of the Macintosh** 1) with Macwrite 2) make the tables using EXCEL
- make a frame using EXCEL	- make the frame
- once the program is charged, - make the modifications	- give the dimensions - define the columns - enter the data.

Appendix E.4.3

Register the cheques : comparison with the subject's known procedures (subject 8)

	Deal with temporary employees
	* Print out a provisional decision
* Reread the cheque	* Check the list of employees
* Mark off - make a form if it does not exist: in the name of the person for the rent and quarterly for the charges.	* Cancel and add employees - create the new employees - enter the data for the employee - state the months
- see if the sum corresponds	* Send the statement about the temporary employees every month: - print out the statements - group them by project - send them to the project for a signature
	* Mark them off when the statements return - check that the employees have been notified
- tick off	- tick them off
* Register in a second place (receipts/expenditure) - in an accounts book - or with EXCEL	
* Pay in the cheques at the bank	* Do the decision - print out the decision changing certain data
- sign the backs	- get them signed
- sort them according to the bank	
- make a photocopy to keep a copy	- make a photocopy
* Send a receipt	* Transmit to the wages department

Appendix E.4.2

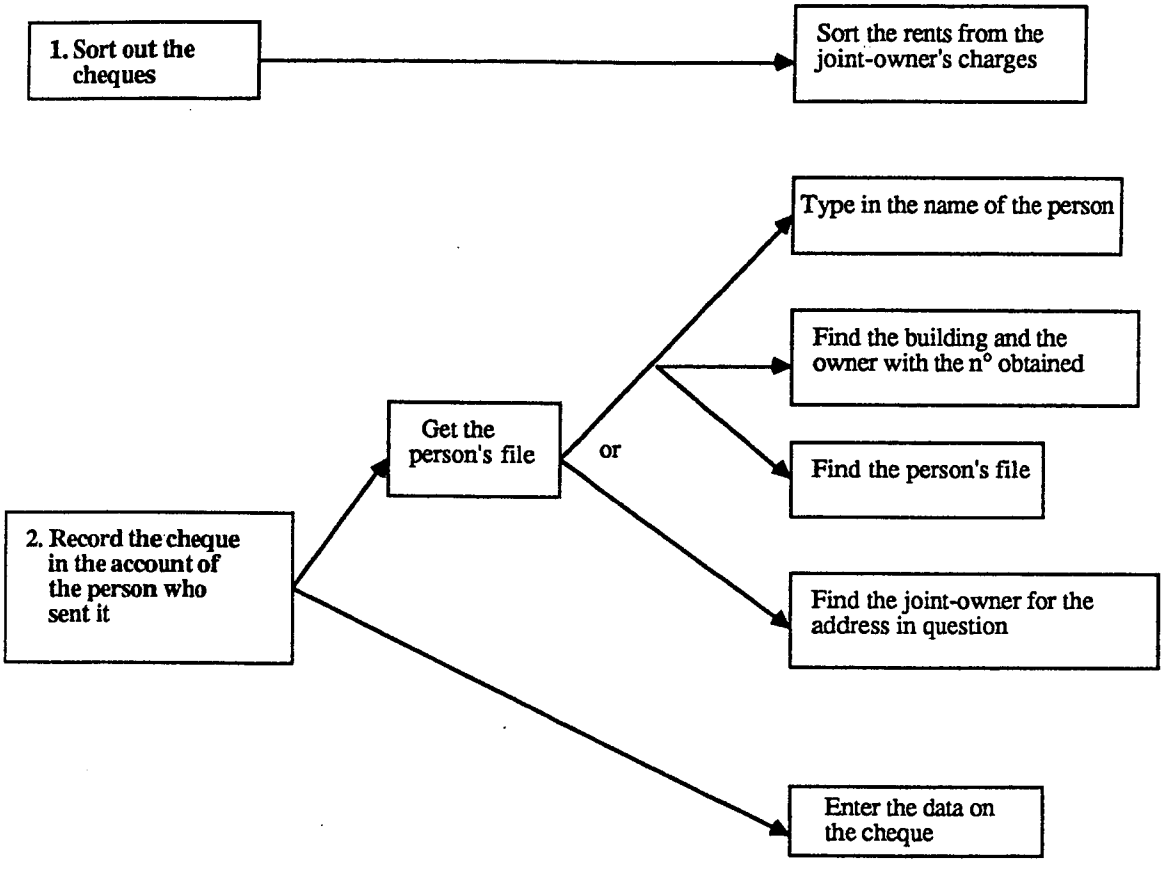
Register the cheques : quantitative tables of the procedures planned by the subjects

* Sort : rent/joint-owner	n = 4
* Check the cheques	n = 4
*** Register the cheques (1)** 1. Get the person's file - computer file (7 subjects) - a "paper" file or form (7 subjects) 2. Record in accounts - accounts file in the system (2 subjects) - in an accounts book (6 subjects)	n = 10 n = 8
*** Send or pay in the cheques at the bank** - do the accompanying form (6 subjects) - sign the back of the cheques (3 subjects) - classify according to the bank (2 subjects)	n = 8
*** Other actions** - keep a copy (relevant papers or photocopies) and file them (6 subjects) - send a receipt (2 subjects) - check the payment and send reminder letters (2 subjects) - pay the owner (1 subject) - check the paying in of the cheques (1 subject)	

(1) Only one subject didn't register the cheques in the way we intended, registering for her consisting of filling out a special form (appendix E.4.4.)

Appendix E.4.1

REGISTER THE CHEQUES
(Control Subject)



Appendix E.3.7

Check and settle 3 invoices : comparison with the subject's known procedures (subject 9)

	Sub-contract management
* Check with the papers in the file * If they conform deal with the payment - find the means of payment in the "suppliers" file (methods) - determine the due date (automatically or ask the accountant)	* Study the file - .... * Deal with the payment (Prerequisite: know the market rates) - choose the means of payment - choose the due dates - updates the accounts
* Settle the invoice - account in the account book the invoice analytical allocation of the joint-ownership), - or prepare charging to analytica accounting (account book to be updated periodically): see the accountant and prepare the payment * File the invoice -	**Presentation of the accounts:** * Prepare the balance sheet - use the "Tosca" software package - do the resulting accounting = classic accounting - make the appendices = analytical accounting - print out obligatory account book - make a statement of accounts = balance the accounts

Appendix E. 3.6

Check and settle 3 invoices: Comparison with the subject's known procedures (subject 14)

* Check with the estimate,, the contract or the last invoice * Register * Make out the cheque - make out the cheque with the invoice - rubber stamp the invoice (the stamp representing a register) - write on it: - the n° of the record * Do a letter to accompany the cheque: - draw it up alone or use a "prepared" letter" stored in computer memory - print it out or photocopy it - add the sum due and the name of the supplier - add the signature (the manager or myself) * File the invoice with a copy	**Make out the cheques** * Put the cheques to one side and the folder to the other ... * Make out the cheque - take the invoice - make out the cheque and fill in the counterfoil of the cheque - rubber-stamp the invoice - fill out the stamp - put in the date and the name of the bank - also put the n° of the cheque on the original invoice . * Do a letter to accompany the cheque Prerequisite : have in the SM90 a standard letter type - enter the data - check and say it is OK - print out the letter - get the letter and cheque signed put the letter in the folder with the letter and the invoice underneath * Transmit it all to the accounts (dept.) - check that everything has been signed and that the total of all cheques corresponds to that given by accounts department. - make photocopies of the letters and the cheques - staple the photocopy of the letter to the invoice - transmit everything to the accounts (dept.) to be sent off and filed.

Appendix E.3.5

Check and settle invoices: comparison with the subject's known procedures (subject 12)

* Take the "order" file and from it by alphabetical order the supplier (cleaning materials, elevator, roofing...) * Check 1) cleaning materials: - take the order form - check the price and that there is the delivery form or receipt 2) elevator: - check there is the form certifying the visit - check with the maintenance contract the number of hours' work and the estimate of the landing door 3) roof maintenance - check the price with the estimate - check the time of the guarantee (with the estimate) has expired. * Settle: - make out the cheque - sign it or get it signed - make 2 copies of the invoice - send off the cheque with a copy of the invoice to the person concerned - write "paid" on the invoice and the copy to be kept with the cheque n° and the date * File : - an invoice in the "supplier" file with the order form, the delivery form, the "visit form", the contract or the estimate.. - the other invoice in the "invoice" file , in the "accounts" file * Later, take the "accounts" file - make the expenditure statement for each building - distribute the tenants and joint-owner charges	**Deal with orders** - Make out the order and keep a copy - File the order in the "orders" file * Check and sign for the goods: - unpack the goods - take the delivery form - tick off with the order form - check: - the serial number - if there is a technical handbook .. * Invoice receipt: - tick off the order "delivered and invoiced" - put together the order form, the delivery form and the invoice - take out the file and put it in the "order archives " (records) - at the same time make an inventory form * Later: - sort by large boxes (suppliers) - take the "orders-archives" file - put the orders together - make the same filing on the Macintosh - deal with the due dates - deal with the reminders of the due dates - at the same time prepare the expenditure statements, invoice summaries, etc.

Appendix E.3.4

Check and settle invoices : comparison with the subject's known procedures (subject 3)

Check and settle the invoicewith the estimate	**Deal with orders**
* Check the invoice against the estimate: - get the estimate from the chronological file under the heading "maintenance" - see if the sums correspond - sign the invoice (prerequisite: agree with the sum) * Authenticate the invoice - mark "OK for payment" or "OK for settlement" * Keep a photocopy of the invoice * Send the invoice to the accounting agency * File under the heading "running of the building", "maintenance section", file the invoice and estimate together	* Make out the order form and send it off .... * Check and sign for the goods on delivery and the guarantee - check the conformity of the goods - sign the receipt i.e. the order form * transmit the invoice to the juridical department - authenticate the invoice - make a photocopy of the invoice - transmit the invoice to the juridical department - file the photocopy with the order form i.e. the original form, under the heading "order X"

Appendix E.3.3

Settle the invoices : quantitative table of the procedures planned

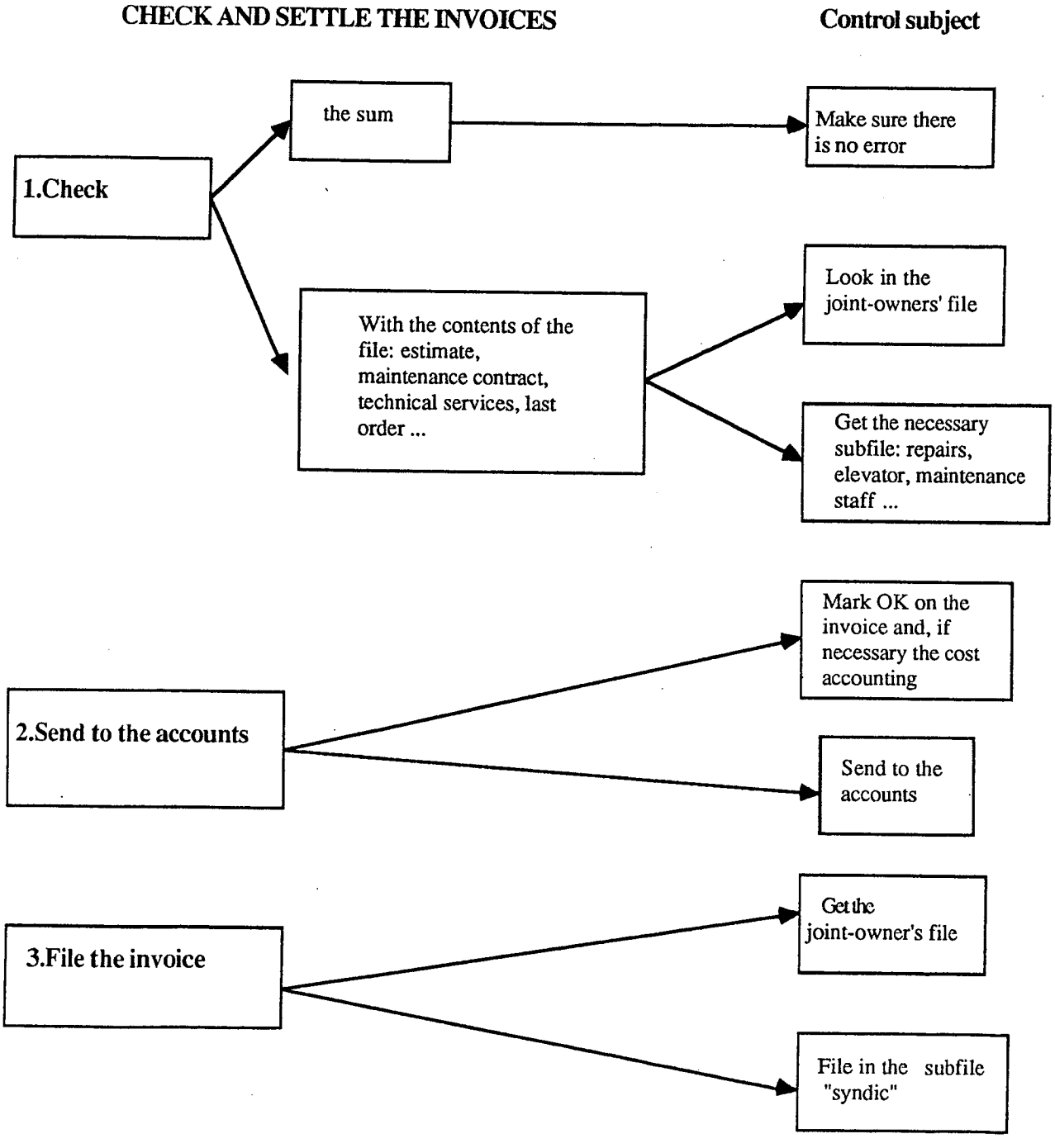
Settle the invoices	
* no precision given	n = 3
* make out a cheque - get the cheque signed (3 subjects) - send off the cheque (1 subject) - enclose a letter (4 subjects) - keep a photocopy of the cheque (2 subjects)	n = 11
* refund (the cleaner)	n = 4
Send to the accounts	
* transmit for settlement Prerequisite : valided invoice (1 subject)	n = 2
* and for the general accounts	n = 1
Carry out the accounting activity	
* record - on the invoice (8 subjects) - "paid the (date).." (7 subjects) - cheque n° (5 subjects) - in an accounts book (9 subjects)	n = 15
* enter the data for the tables or summaries, update	n = 11
* get a refund by inclusion in the charges	n = 3
File	
* the invoice	n = 12
* a photocopy	n = 7
in: - the accounts (5 subjects) - the joint-owners' file (7 subjects) - the supplier's file (1 subject)	

Appendix E. 3. 2

Check the invoices: quantitative table of the procedures planned by the subjects

* check the calculations	n = 9
* check the conformity to - the estimate - the maintenance contract - the last invoice or order form (from the cleaner)	 n = 16 n = 14 n = 4
* check the work done (call the technical department)	n = 6

Appendix E.3.1



PR: The invoice has been recorded
on the accounts computer system,
and has been returned.

Appendix E. 2. 5

Make a new file (Subject 3) :comparison with the subject's known procedures

Make the file for the rent	**Type an article using Mac or ETAP**
- Take a rent contract : a standard contract type, and - Format using the text editor - Fill it out... - Get it signed	- Use the "Edition" program on a disk - Format and page set up
- Send or give a copy of the contract to the person - Keep a copy: put in the archives in the rent file under the name of the owner in alphabetical order - Record in the accounts book the rents paid - Record the tenant in the file (in ETAP) for the future meetings	**Put down somebody as a member of the Company** - Check that the form is correctly filled out - File it in alphabetical order - Record in a book the cheque. - Check whether the person is included on the terminal & if not enter the name

Appendix E.2.4

Make a new file: Comparisons of the subjects'representations (extracts)

Procedures planned for the experiment	**Usual procedures used by the subjects**
(Subject 5) Establish a contract: - file the contract - on the activity/time chart = add a card with the person's name in the chart for the building in question	*Allocate space in building offices (Subject 5)* (after having been notified of someone's arrival) - find the person a place - update the chart of the building write the name of the person.
(Subject 4) - Have the standard memo on which: tick off progressively the things done	*Prepare the seminars (Subject 4)* Make up the file: - take an archive box - add a card with the title etc.. - tick off progressively the documents
(Subject 16) 1.Make a computer file... 2.Make a "real" file ... 3.Use the same reference for each type of file	*Filing documents (Subject 16)* 1.Enter the documents into the Multics system 2.Stock all the documents in the cupboard 3. Change the headings when necessary: write the new headings on the terminal and in the cupboard.
(Subject 9) - Prepare a"living" (paper) file,with ... - Enter the data in computer file	*(Subject 9) Remark made by the subject about her work)* "...I like to have the information in two places: - a filing system with the documents - a computer file
(Subject 2) - Made up the file - Type the contract with ...	*(Subject 2) Remark made by the subject during experiment* "Well, I'm thinking about what we do here when we make a contract

Appendix E.2.3

Prepare the rent contract (or the lease)
Quantitative table of the procedures planned

Type the lease 1.Use a standard contract type - take * a printed sheet (5 subjects) * a standard contract type and reproduce it (5 subjects) - fill it out (9 subjects)	n = 10
2. Do the contract - without specifying how (2 subjects) - with a typewriter or with Macwrite (2 subjects)	n = 4
3. Simply make sure that the lease is there	n = 1
Make n copies - carbon paper (1 subjects) - photocopy (2 subjects) - print n copies (4 subjects)	n = 6
Get it signed or wait for it to be signed	n = 11
File the original or a copy in the file - under the tenant's name (7 subjects) - one extra copy under the owner's name(3 subjects) - in the building or owners file (3 subjects) - without specifying (1 subject)	n = 11

Appendix E.2.2

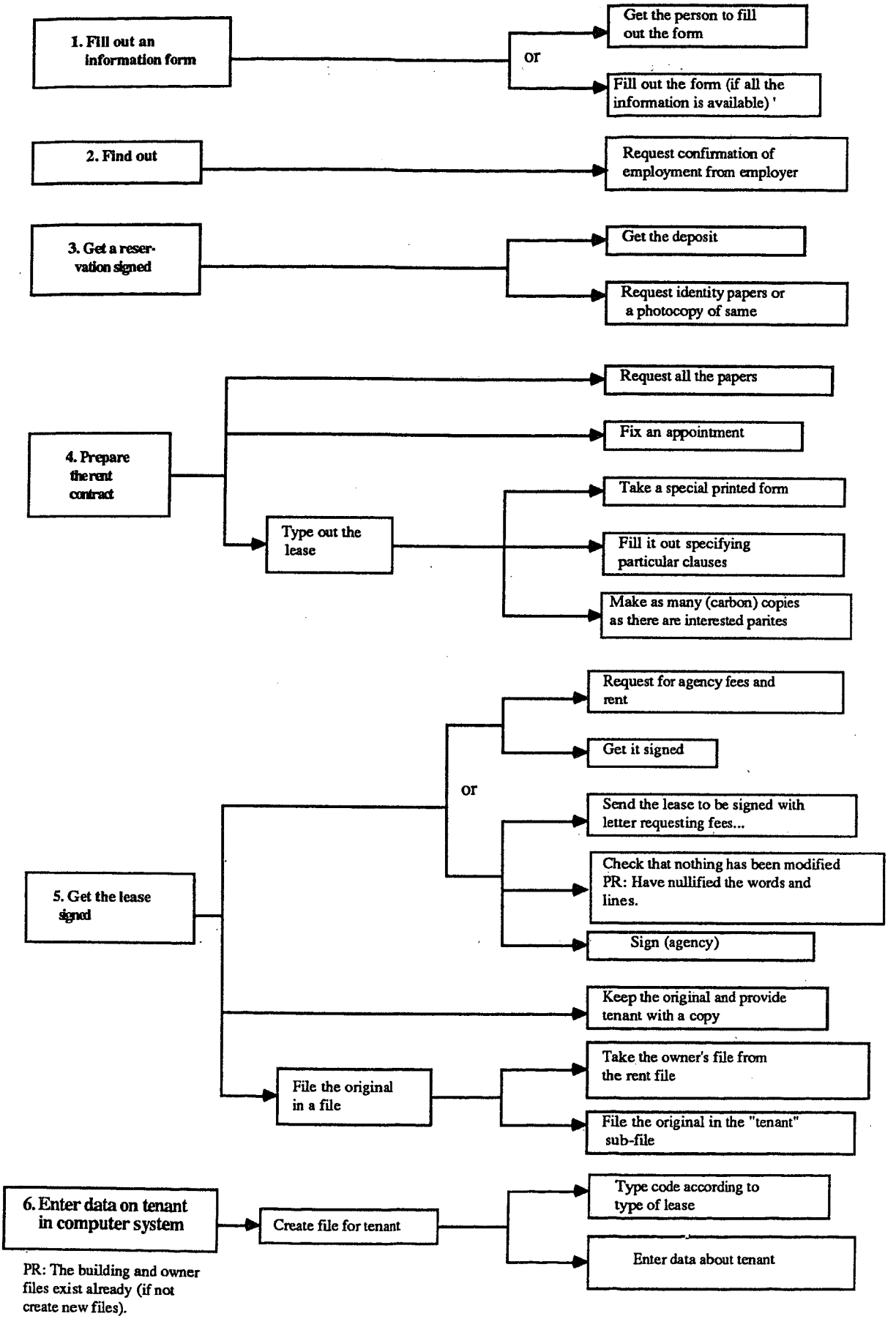
Make a new file: Quantitative table of the procedures used

File - Fill out a form	n = 3
- Paper file	n = 14
Get information	n = 4
Deposit	n = 9
Prepare the contract	n = 13
Get the lease signed	n = 10
Enter data about the tenant in the computer system	n = 10

Other actions planned

- register the data in a book or file (n = 7)
- register the cheques (n = 4)
- give the keys to the tenant (n = 1)
- fill out forms other than the file form (n = 3)
- update the activity/time chart (n = 1)
- make out a receipt (n = 1)
- open an account for the client (n = 1)
- send it to the accountant (n = 1)
- prepare a small file to give to the tenant (n = 1)
- write to the bank (n = 1)

Prepare a new file (Control Subject)



PR: The building and owner files exist already (if not create new files).

Appendix E.1.6

Send the letter: Procedures (Quantitative table)

Send off	All subjects except 4*
- registered letter	n = 1
- with acknowledgement of receipt	n = 3
Enclose the accounts statements	n = 10
Check: - enclosed papers	n = 2
- in general	n = 2
Keep a copy:	
§. a copy or photocopy	
- in a file	n = 3
- in chronological file	n = 3
- in the machine (the letter)	n = 1
§. keep the list of addressees	n = 3
Record	- 1 subject ticked on 1 list - 1 subject wrote "sent" on the copy

* 3 Subjets enclose the statements, 1 subject sticks labels on the envelopes

Appendix E.1.5

Procedures usually used by the subjects	**Procedures planned by subjects during the experiment**
* Use a series of labels *(Dealing with meetings: send the notification of the meeting to all the members* - enter the notice of the meeting on the ETAP - make 100 copies - send off to each member - print a series of labels - file the original	- draw up and enter the letter on the ETAP text editor - take the file of the joint-owners from a disk - print out the name and address on the letter automatically (enter the necessary commands) - print out a series of labels - send off to each person - keep and file a copy of the letter
* Using headed writing paper *(Do the letters for the club with the Macintosh)* - use "Word" to type the text - format - print it out on headed paper - print out the necessary number of copies *(Make interdepartment memos)* - take a special writing paper	- Do a standard letter type on the Mac. - take headed writing paper - draw up the letter - type it out once on the Mac. - Print out n copies - find list in the file - Send it all off to the persons concerned --- - Do the standard letter type on the Mac. - on the company writing paper
* Using different files *(Update the files)* - a mailing list file for sending documents - and an address list file	- using the computer, print out the address list file of the joint-owners - do the letter -... - call another file which prints out the address automatically to stick on the envelopes
* Make a rough draft *(put in an order)* - make a rough draft - type out the order....	Do the letter: - make a rough draft of the letter - type the letter ...

Material used / Actions making up the procedure	Macintosh n = 6	Text editor: ETAP; TTX... n = 8	Type writer n = 2
Do a model letter "type"	n = 5	n = 7	n = 1
Take a standard letter "type" or a model and modify it	n = 1	n = 2	n = 1
Take the list of joint owners * from a computer file	n = 3	n = 4	n = 2
id * from a manual file	n = 0	n = 2	n = 1
Make n photocopies of the letter	n = 1	n = 1	n = 1
Print n copies of the letter changing the name	n = 3	n = 4	n = 0
Print n original copiesof the letter	n = 2	n = 2	n = 1
Print a series of labelswith the name and address.	n = 0	n = 2	n = 1

Do the letter: Procedures (quantitative table)

Procedures usually used by the subjects	Procedures planned by the subjects in the experiment
(Summarize in a table the accounting commitments) - make a table using EXCEL - take the forms and mark the commitments - print out statement showing amount available	*(Accounts statements)* call the file for each owner on the Macintosh with their payment of charges : - use the EXCEL speadsheet - with the payments marked - and the amount owing
(Update the contracts using ETAP) - make the modifications using ETAP - print out the document - take the old contract out of the file and put in the new one	Write or enter the joint ownership accounts, which should have been updated: - if using a computer: print out a situation
(Update the accounts commitments according to available credits) - check the amounts available - print out the new available sums for each center, using the Mac	- draw up the credit/debit - print out the accounts statements using the Macintosh
(Update the accounts) - summarize tables: enter all the commands (table, columns, rows ..) - fill in the figures and data - print out	- take the "accounts statements" disk - for each joint owner find: - the sums paid - the sums outstanding - a plus/minus column, and see if a sum is outstanding

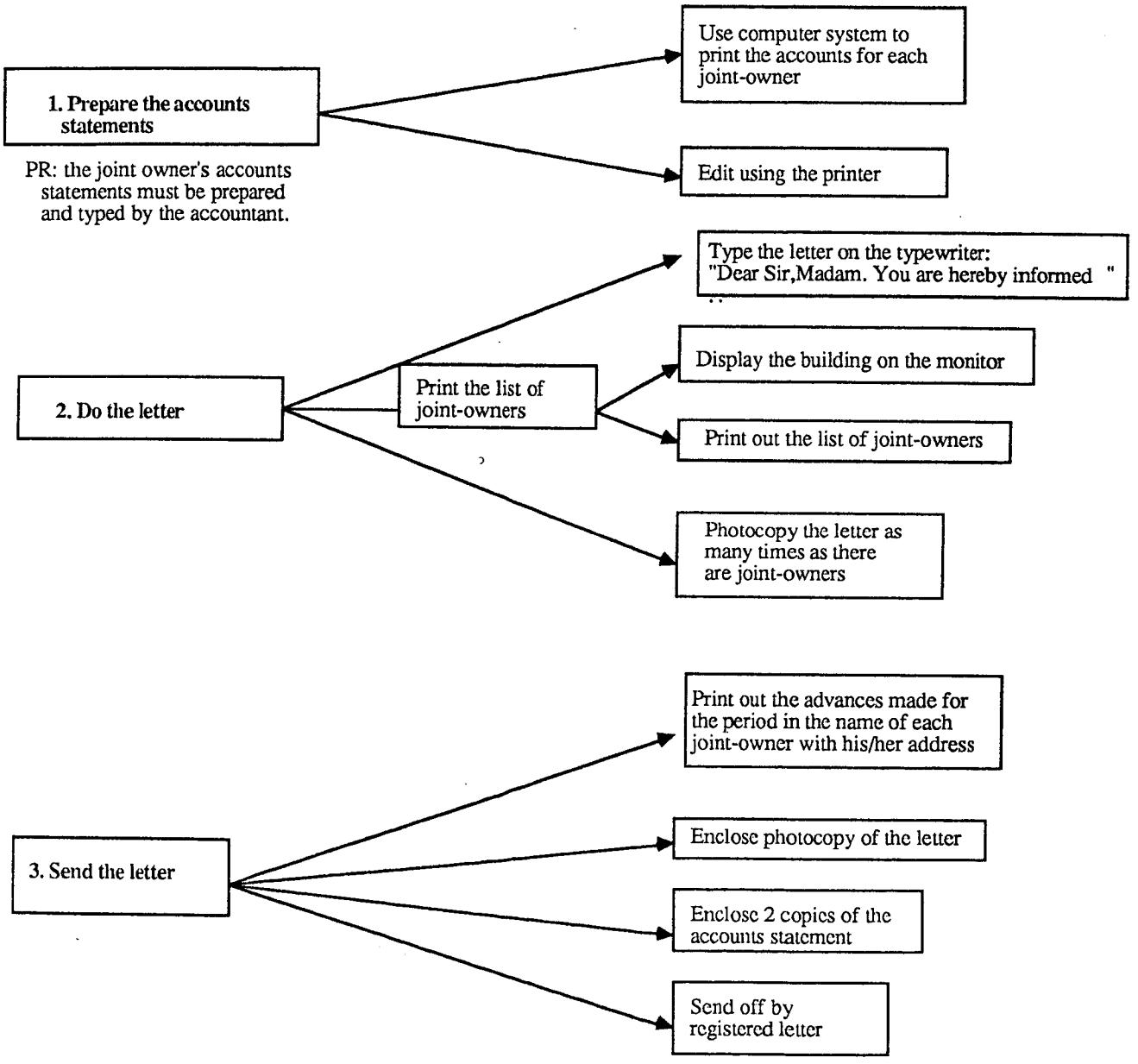
<table>
<tr><th colspan="2">Take the already prepared statements
n = 9</th><th colspan="2">Use computer system
n = 6</th><th>Take the accounts book and do the statement</th></tr>
<tr><td rowspan="3">Ask for it from the accountant
n = 3</td><td>Take from the file
joint owner n = 5 | building n = 3</td><td>Ask the system
n = 3</td><td>Edit or print out
n = 6</td><td>n = 3</td></tr>
<tr><td>enclose n = 4 | photocopy and enclose n = 2</td><td colspan="2" rowspan="2">+ photocopy
n = 1</td><td rowspan="2">+ photocopy invoices
n = 2</td></tr>
<tr><td>Make a sort of invoice and enclose
n = 1</td></tr>
<tr><td>TOTAL
N = 3 subjects</td><td>N = 6 subjects</td><td colspan="2">N = 6 subjects</td><td>N = 3 subjects</td></tr>
</table>

Prepare the accounts statements : procedures used*

* 3 subjects did not enclose the statements, however many subjects planned various possibilities.

Appendix E.1.1

SEND THE LETTER FOR THE MEETING **Control Subject**



The following appendices concern the experiment and contain detailed results.

For each task proposed:

- the control subject's representations
- quantitative tables of the different procedures planned by the subjects. The total number of subjects, regarding the procedures, may differ from the total number of subjects taking part in the experiment as certain subjects proposed several procedures;
- the matching (parallel) of subjects' verbalizations* about the planned procedures together with the descriptions/or parts of the description of the tasks that they usually carry out in their work.

We call "subjects" those persons who took part in the study. Each time we wish to refer to the control subject, we shall specify "control subject"

The notation used in the appendices is the following:

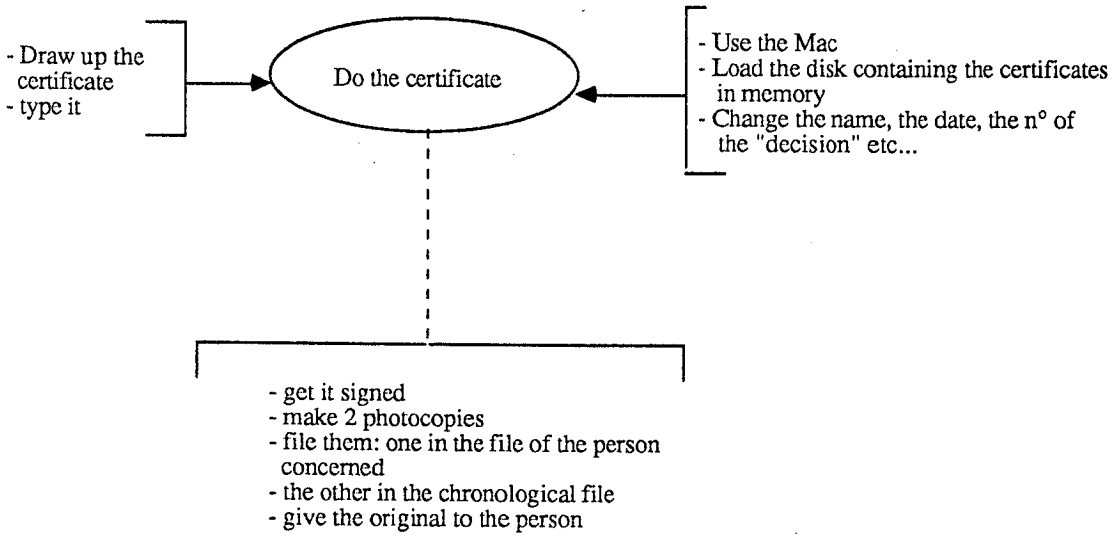
- E = experiment
- the first number refers to the task proposed
- the second number corresponds to the appendix n°
- PR= prerequisite

Example : E,1,1. Appendix 1 of the first task analyzed in the experiment.

* The subjects' verbalizations in the tables are translated from French.

APPENDIX 6

"Do a certificate"

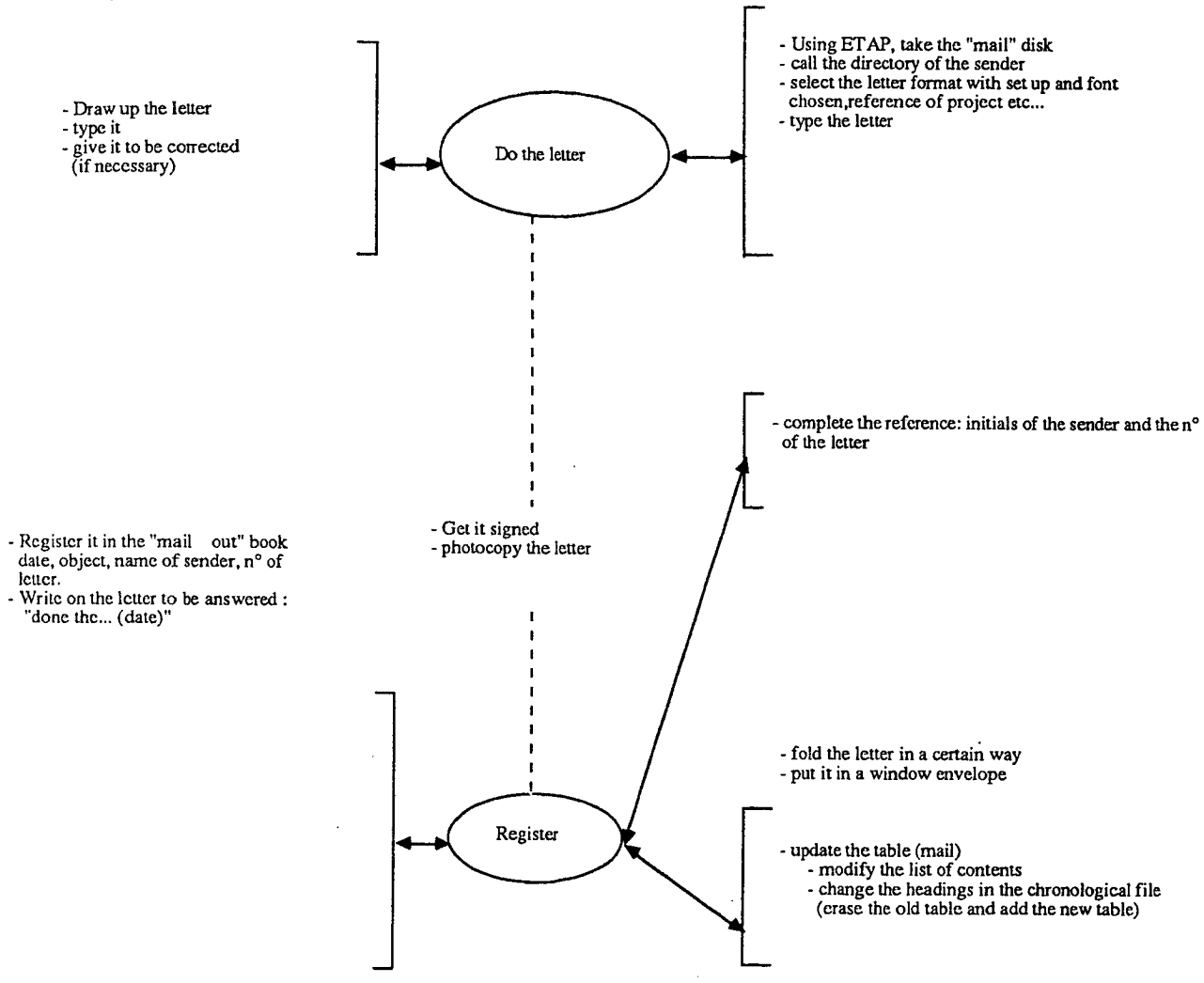


Subject 2

APPENDIX 5 CONTINUED

Answer the mail

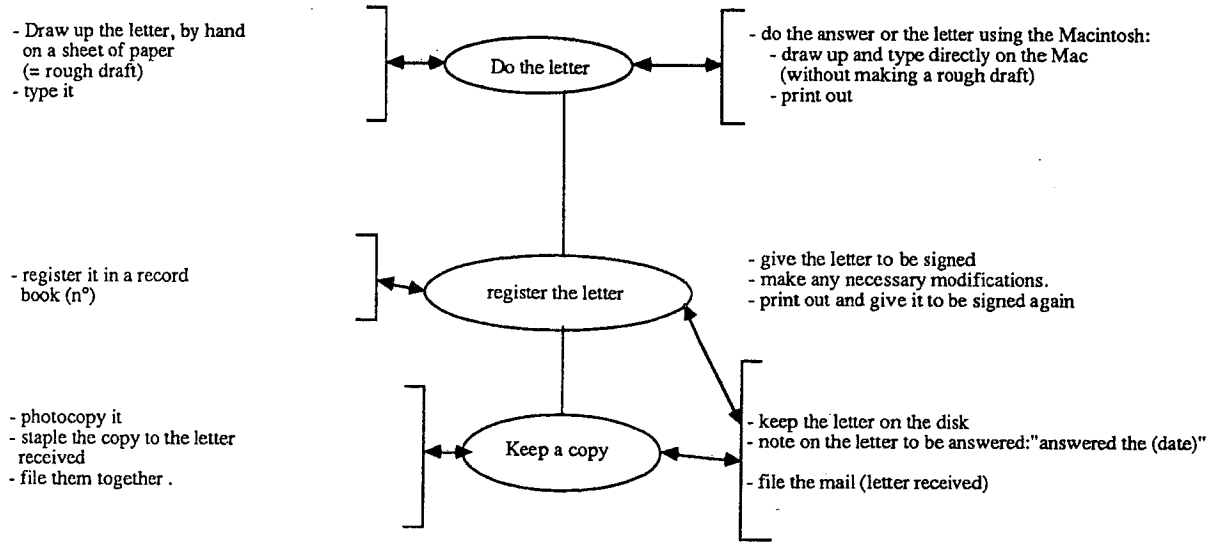
Subject 6



APPENDIX 5

Answer the mail

Subject 4

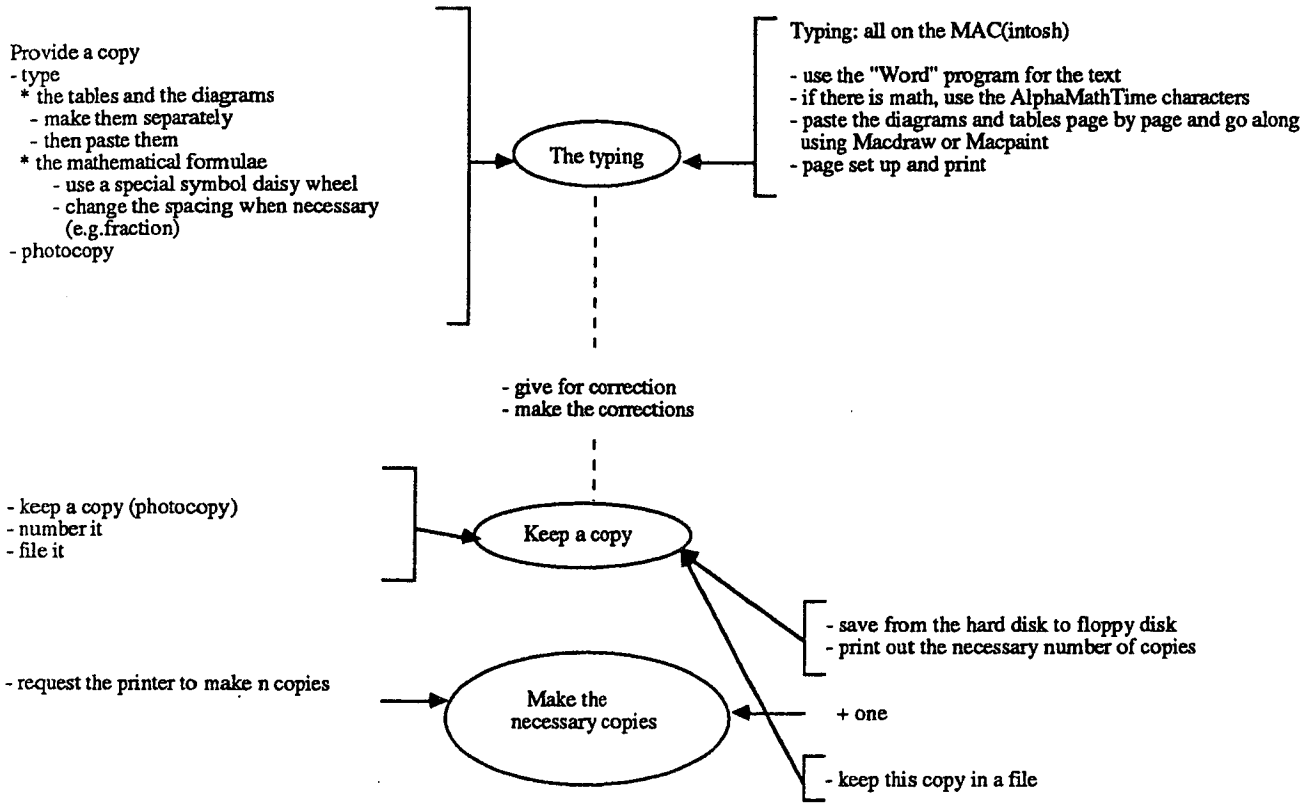


Appendix 5 continued next page

APPENDIX 4 continued

Type a scientific article

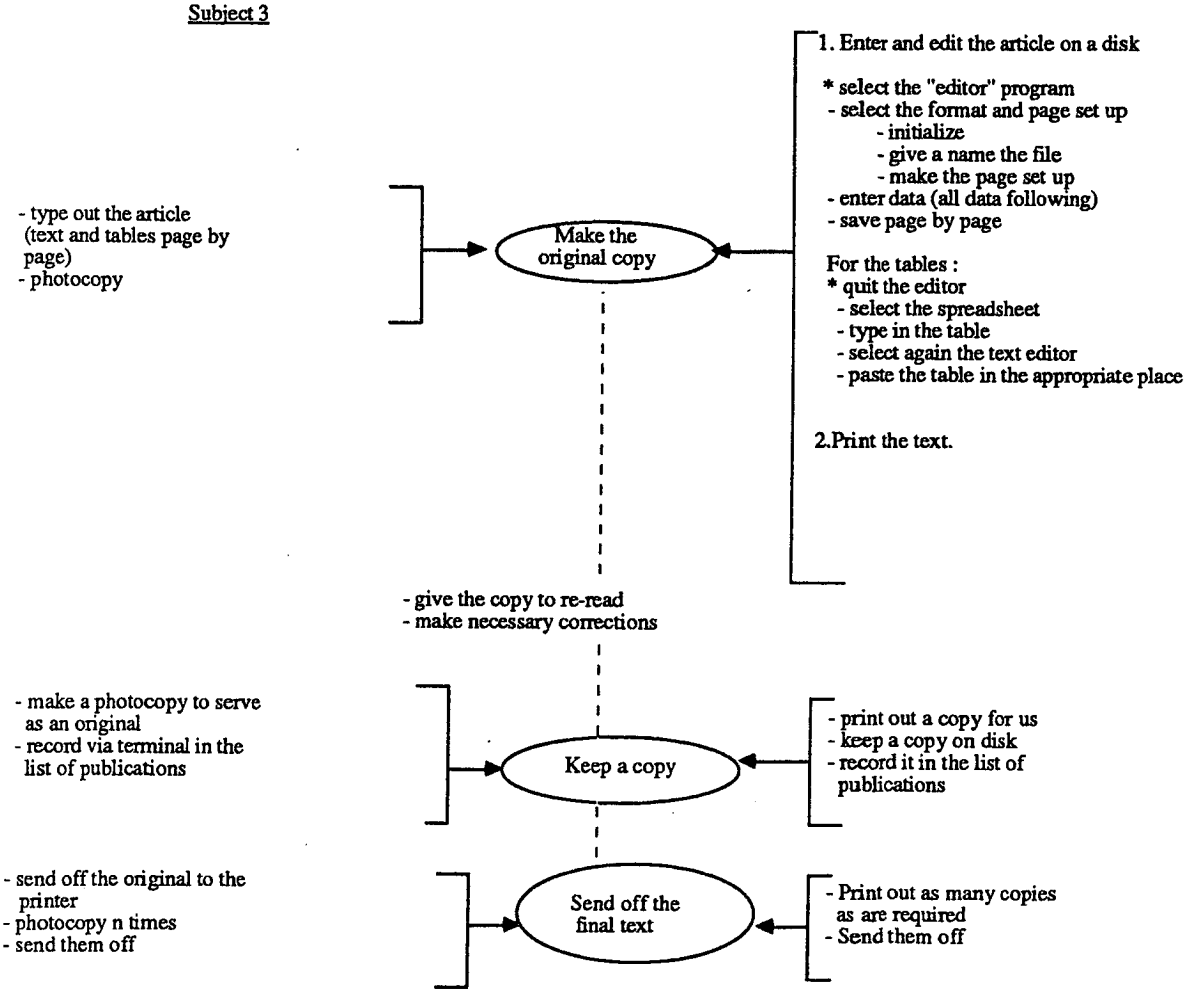
Subject 5



APPENDIX 4

Type a scientific article

Subject 3



Appendix 4 continued next page

APPENDIX 3

Spontaneous verbalization : example

"My work consists of looking after the ticket reservations for people going on business trips: (persons from INRIA or outside, trips inside France and abroad)

I deal with everything to do with the journey. When I receive a request for the authorization of a business trip, I deal with:
- reserving the ticket (plane, train, boat)
- conference registrations
- visa applications

After that, there is all the filing:
- filing the paid invoices
- filing all the documentation
- filing the individual tickets (photocopy of the ticket and receipt)

I also have to return the cheques to the AVO agency
- filling out a special form
- inclosing the documents
- filing the special form

I forgot to tell you, I also enter data about estimated budget states i.e.
- enter data about authorizations of business trips on the terminal
- transmit the file to the person who will enter the data for the trip."

Subject 11

APPENDIX 2

The instructions given for the experiment

Imagine that for one reason or another, starting from today, you are no longer working at INRIA, but in an estate agency*. Due to your previous experience (gained at INRIA) the manager of the agency has faith in your abilities and has outlined your work as:

- answering the mail
- managing the joint ownership of cedrtain buildings,
- looking after the rents,
- keeping the accounts up-to-date.

For today, the manager has specified certain urgent tasks that you must carry out:

- register the cheques that have arrived this morning;
- send off to those concerned, the letters for the annual meeting of the joint owners of 6, rue des Violins;
- prepare a new file for Mademoiselle Guitar who is coming to sign a rent contract this afternoon;
- make an accounts table summarizing Monsieur Piper's rent and extra charges for the first quarter, as he is leaving his apartment and returning the keys tomorrow;
- check and settle the three invoices that arrived yesterday.

Please explain to me what you intend to do and how you will go about accomplihing these tasks. You are in an office which is similar to this one and you have the same equipment at your disposal.

You may think about the tasks and ask questions before giving your explanation.

* The Harmonic Housing Agency
8 Baton Boulevard
98400 La Fugue.

APPENDIX 1

Questionnaire*

Three years ago you accepted to take part in a study carried out by Ergonomic Psychology project. I would be grateful if today you would answer the following questions:

1. Do you still work in the same department ?

Yes No

In either case, please give the name of the department or project in which you work.

2. If "yes", have there been changes in your department?

- reorganization of the department, new distribution of tasks, computerization, etc.
- new equipment: word processor, Macintosh, SM90, terminal connected to the Multics system, etc.

Please specify the main changes:

3. If "no", does your work seem very different?

Please specify the main differences.

4. What does your work consist of?

Please list the main tasks that you have to carry out:

* This questionnaire was answered by the subjects who had taken part in the previous study.

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Lichtenstein, E.H., & Brewer,W.F. (1980). Memory for Goal-Directed Events. *Cognitive Psychology* ,**12,** 412-445.

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Richard.J.F. (1986). The Semantics of action; Its Processing as a Function of the Task. *Research Report n°542, INRIA* , Rocquencourt, 78153 Le Chesnay, France.

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4. Sometimes certain details do not appear in the subjects' representations. However this does not necessarily mean that these details are not included in the action schema. It may be that they were implicit for the subject, or that she omitted them as she was not in a real work context.

5. Finally, it must be said that although the schemata that the subjects have may be made up of goals (the result of a decomposition), various procedures may be employed to achieve these goals. This is clear whenever a subject proposes two ways of carrying out the task: either manually (using a pencil, paper, files and filing cabinet) or by means of a computerized system. It is worth noting that whenever they have the choice, the subjects prefer a computerized system.

The fact that the subjects were not in a real work situation is open to criticism, but this would have been difficult to achieve:

- as it would have been difficult to find a work location where such an experiment and the presence of outsiders would have been accepted,

- but above all because, given the nature of the experiment, it was impossible to foresee and provide the subjects with the same (material) environment as in their real work situation.

Regarding the choice of the tasks: in order to identify the action schemata, it was important that the tasks proposed should not greatly differ, from those that the subjects usually carried out. The subjects' professional activities varied widely, which explains why we had to fall back on the relatively common, and therefore simple tasks which we had previously observed,such as sending a letter for a meeting or making up a file. Nonetheless, we deliberately combined them with other, more specific tasks such as accounting.

Our aim was to identify the schemata contained in memory, to see how they are built up and how they are employed to carry out tasks. We also raised the question of knowing which action schemata should be used to assist systems design.
Making use of existing action schemata is certainly one interesting approach. However, we should bear in mind Anderson's criticism of schemata, namely that the distinction between the declarative and the procedural remains unclear. We believe that it is important to not lose sight of the declarative aspect and the procedural aspect in a given activity and to make a clear distinction between the result of an action and the procedure(s) employed to achieve this result (Sacerdoti, 1977 and Richard ,1986).

As the two examples presented concern the same experimental task, it was possible to note the differences illustrating the existence of various schemata for the same task. It is necessary to identify action schemata as a system's users must have the possibility of using the schemata that they know in order to carry out a task. The action schemata incorporated in the system should therefore relate to the task as a whole, but also to parts of the task and should correspond to schemata which allow new schemata to be constructed. In this case, it would also be useful to provide the users, if they so wish, with indications of which procedure to apply (expert level: domain specific procedures (Sebillotte, 1988) in such a way that enables the subjects to use the schemata that they know to build new schemata when they do not possess the adequate schemata for carrying out the given tasks. In this way, the system will be compatible with the logic of its different users.

DISCUSSION

Among the results presented in this paper, two points should be stressed concerning the representations that the subjects have of their usual work activity:

- firstly, the spontaneous verbalizations that the subjects gave confirm previously obtained results in that the subjects have a hierarchical representation of their activity;
- secondly, by interviewing a number of subjects on their work after an interval of three years, we were able to show that their representation of the activity does not change from a declarative (goals to achieve) point of view, and that only the procedures employed to achieve ceratin goals are modified.

This supports the view of Roberts and Moran (1983) who stated that the breaking down of tasks into goals and sub-goals is a more constant feature than the description of the task by the methods used to complete it, which may be modified due to the person or certain external changes.

It may also be said that when the subjects have a clear understanding of what they want to accomplish, they have little difficulty in adapting to new procedures, and in particular those involving automation.

The existence of action schema contained in memory was clearly demonstrated:

- each time the subjects closely followed procedures which they already knew,
- and by the procedures which they adopted: there often exist what may be called "secondary actions" which vary from individual to individual, and which allow us to identify the subject's procedures.

The main results of the experiment may be summarized as follows:

1. Faced with an unfamiliar task in an usual work context, the subject may assume that it belongs to the same class as a task with which she is familiar through her usual work. The subject then uses the schema of the task she knows in an attempt to carry out the unfamiliar task. In such a situation, the procedures adopted by the subject are identical to those which she uses during her usual activity to perform a specific task.

2. When the subject cannot match a new task to a class of tasks, she will break the new task down into sub-goals which she will then try to attain by using, when necessary, more elementary action schemata which she knows already.

   This is the case for subjects that we found to have incomplete schemata for different tasks, and is in keeping with the findings of Rumelhart and Norman (1981) whereby new schemata with more complex procedures are created by appreciably modifying existing schemata. These new schemata may sometimes prove to be inadequate for the task in question.

3. The problem that the subjects encounter when trying to carry out a new task are due to the fact that they attempt at all costs to match their method of carrying it out with a known schema which does not exactly correspond to the new task. This was the case for almost all the subjects who had trouble drawing up an accounts table summary.

The new action schema that the subject has built up for "preparing a file for someone who is coming to sign a rent contract" is:

- prepare the contract, i.e. fill out a special form,
- prepare a small file, i.e. put into an envelope the various documents that may be useful to the future tenant,
- get the contract signed,
- then send off copies of the special form following the administrative requirements of the estate agency.

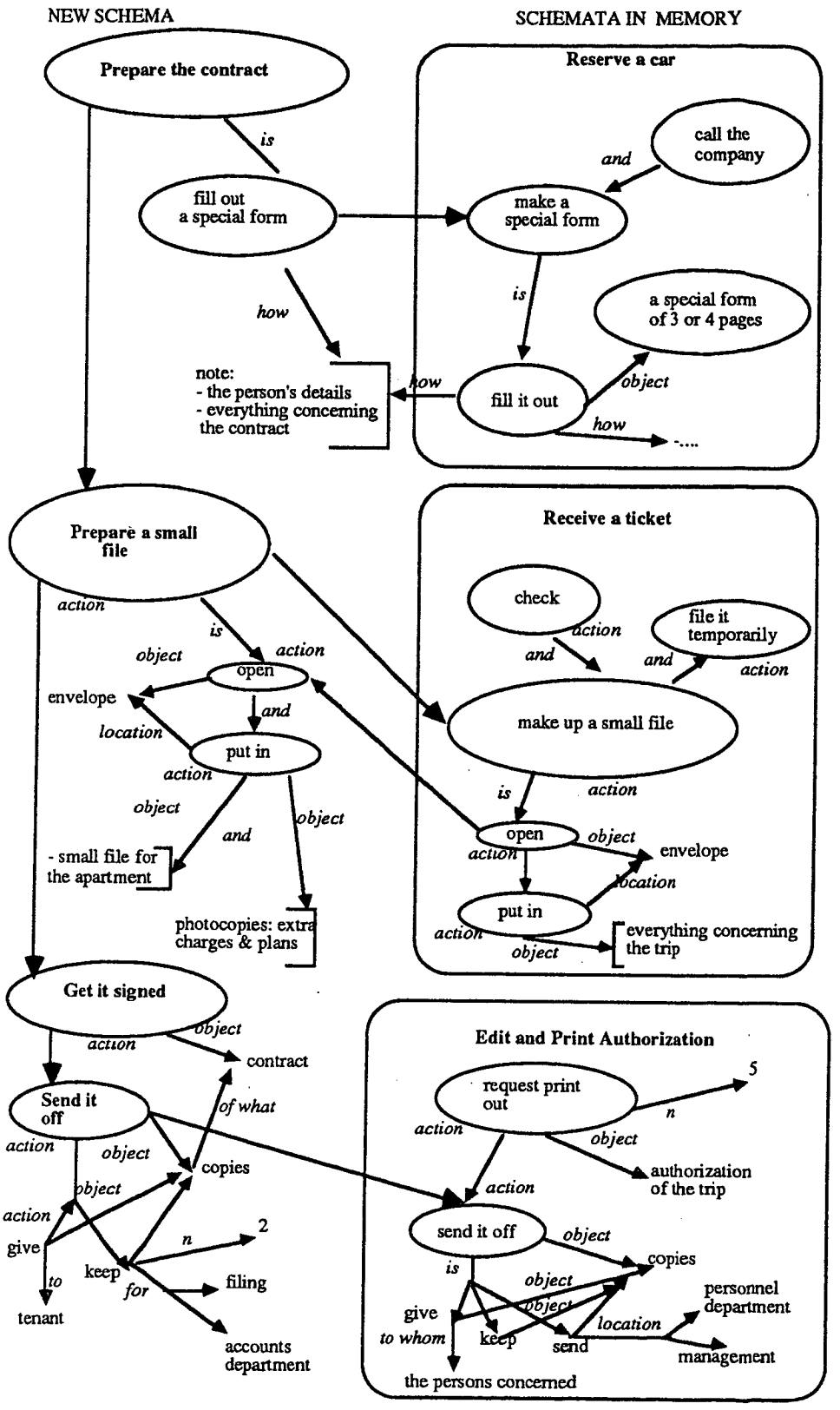

FIGURE 4: Building a new action schema from known schemata

"Prepare a file with an official document "

Using a known schema

It is clear that a known schema is being used when the subject chooses a procedure to carry out the unfamiliar task which is identical to a procedure that she uses in her usual work to carry out another, specific procedure.

Some examples are given in the appendices where the subjects matched an unfamiliar task with one that they knew well and reproduced the same actions in order to carry it out (appendix E.3.4.: dealing with invoices and appendix 8: preparing a file).

In the first example (appendix E.3.4.) the subject is working with a research team and she sometimes has to receive equipment that has been ordered. This equipment is generally accompanied by an order form and an invoice which must be sent to the administration department. The same actions are found in check and deal with the invoices in the estate agents: check, sign, certify, photocopy, transmit or send, file under appropriate headings.

In the other example (appendix 8, and figure 3) the subject, who is working in an administrative department, deals with trainees. When preparing a file for the drawing up of a contract for apartment rental (the task proposed), the subject went about the work in the same way as if she was dealing with a trainee, namely: create a file after having gathered the necessary documents and checking that everything is in order, draw up a "decision" (in this case the contract), copies of which she sends to the departments concerned.

The action schema may be resumed thus:

- prepare a file
- create an official document, i.e. a document authentifying an act,
- get this document signed,
- make n copies of the document,
- transmit the document together with another official document to the persons, parties or departments concerned.

Building a new schema from known schemata

The subjects did not identify the task proposed with a task belonging to a class of which they knew certain elements or a prototype. They therefore broke the task down into sub-tasks for which they had action schemata in memory. As the example below shows (figure 4 and appendix 9), the subject builds up a new schema from other schemata which she has in memory. In her work situation, this subject has to deal with "all travel arrangements for persons going on business trips" and in particular :

- ticket reservations,
- receiving the tickets from a travel agency,
- authorization of the business trip,
- making car reservations,
- making visa applications.

To carry out the unfamiliar task proposed (prepare a file for an apartment rent contract) the subject drew upon action schemata corresponding to certain tasks mentioned above:

- firstly she associates the contract with a special form that she is used to filling out for the authorization of business trips (for this subject, the special form consists of "a printed first page that is duplicated several times")
- then, in order to make up the file, the subject refers to the files that she is used to preparing for persons going on a business trip, i.e. an envelope containing all the documents that may be useful to the person,
- finally, she sends off the contract in the same way as she sends off the authorization of a business trip.

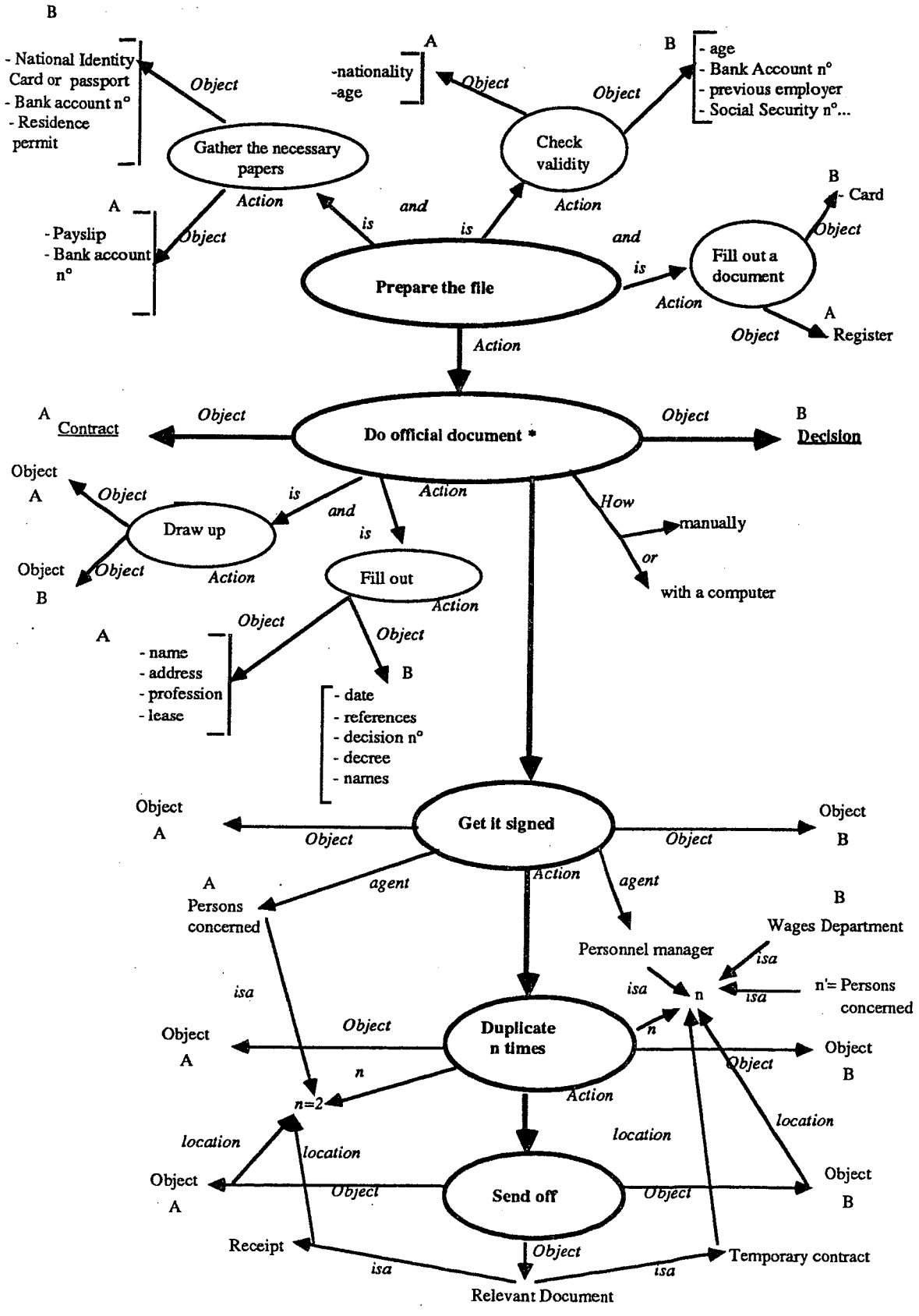

FIGURE 3 : Action schemata: "Prepare a file with an official document"
Instantiation of a known action schema in two situations A et B

* Document certifying an act.

ACTION SCHEMATA

Our aim was to determine the action schemata that the subjects build up during their work experience by presenting them with an experimental task in an unfamiliar context.

This enabled us to find and compare common points between the subjects' representation of their usual professional activity and their representation of the experimental task.

Among other things, we observed that certain subjects seemed to match the experimental task with one that they carried out habitually; other subjects broke the task down into sub-tasks and then matched the elements with sub-goals belonging to tasks with which they were familiar. The subjects used the same procedures (often shown by the sequences of actions which were identical).

When comparing the structures, we considered those which remained constant to be schemata in the sense given by Rumelhart (1978) i.e. blocks of cognition. These action schemata are instantiated by the subjects in order to carry out two types of tasks (familiar and unfamiliar).

The behaviour that led to the matching of a task, or of its elements is in keeping with schema theory, namely:

- schemata are stored in memory and applied when necessary,
- new schemata can be built up from existing, more elementary schemata.

We present below two examples of the use of action schemata: using an established schema, and constructing a new schema from existing schemata.

We have represented the schemata and their instantiations in the form of semantic networks, which are the tools used for studying representations in memory (the knowledge contained in human memory forms a network of interrelated concepts and actions).

The semantic networks are represented in diagrams showing the set of interconnections between the significant (semantic) components in memory. The representation contains nodes whose interrelations are shown by arrows and labelled relations. For a more detailed explanation see Lindsay and Norman (1980, Chapter 10).

The semantic networks make it possible to explain and understand the sentences. In order to discover the basic structure of an event, it is necessary, according to the Linsdsay and Norman model, to firstly determine the scenario centered around the action which becomes the central node. Then we must find the actors, the objects on which the action is made, the agents and the receptors which are linked to the node. In this model "everything is organized around actions" (Weisberg, 1980). According to Sage (1987), a well-constructed semantic network is able to represent the physical characteristics and significant aspects of these actions.

In the figures showing the use of action schemata below:

- the actions (nodes) are represented by ovals around a verb describing the action,
- the actors, objects making up the task (scenario) are linked to the node by arrows identifying their role.

The action schema is shown by different nodes (ovals) and their relations, the arrows, labelled relations and values of the variables specifying the schema's intantiation in situations A and B.

The subjects who had no difficulty carrying out the task (i.e. who did so at the first attempt) are generally those who must do accounting in their usual work (one subject had learned statistics and another had studied accounting during her training). On the other hand, the subjects who had difficulty, had never done any accounting.

All subjects reproduced this summary on a sheet of paper, as had been proposed in the instructions. Most of the subjects then specified that they would use the computer tools available to produce the final copy. Out of these subjects, 4 simply entered data and edited and printed a situation or a state.

The problems encountered

It is only necessary to show the amounts due, the deposit to be deducted and the balance (here= the amount owing) as explained and carried out by expert subject (appendices E.5.2. and E.5.3.)

The main problem was that the rents are presented on a monthly basis, whereas the charge for hot water and the deposit to be deducted are presented as a global figure.
This causes no difficulty when dealing with global figures, but the problem arises as soon as the figures must be presented on a monthly basis. This was the case for all the subjects who made at least 2 attempts. In fact they all begin by drawing up a double entry table with the months in the rows and the headings (rent, deposit, charges) in the columns. It is only when the subjects abandon this representation that they find a solution .

Only the subjects who carried out the task easily could be used for drawing parallels, especially for the design of the table (appendix E.5.4.).
For the others, we find similar procedures regarding the use of a personal computer to edit and print out a situation or a state after having entered data (appendix E.5.5.).

All the subjects deal with the payment, but 3 do not specify the procedure. When the subjects do specify the procedures, they do so with varying amounts of detail: 11 do the cheques and 2 transmit the invoice to the accounts department for payment (appendix E.3.3.).

It is interesting to note that for most of the subjects, settling an invoice involves it being transmitted to the accounts and filing the invoice as is the case for the expert subject. In fact, almost all the subjects (13 out of 16) envisage an accounting process (recording and entering data) and filing the invoice (or a photocopy of it) once it has been paid.

Generally speaking, this task did not pose any problems for the subjects:

- half of the subjects, during the course of their usual work, deal with orders and receive invoices and the representations of such tasks can be readily compared (appendices E.3.4 and E.3.5.)
- for the other subjects, a certain number of common procedures can be found either for settling the invoice or else for filing it, particularly in processing the invoice and its accounting process (appendices E.3.6. and E.3.7.)

4. *Register the cheques*

For the subjects "register the cheques" meant entering the data about the cheques received in an automatic system or writing this information in a book or a file (expert subject: appendix E.4.1.). Only one subject has a different representation which consists of filling in a particular form.

If at this abstract level the representations are the same they nonetheless differ in their details (appendix E.4.2.). In fact we find 2 ways of going about the task which may be "individual oriented" or "general accounting oriented":

* in the first case the subjects approach the task from the individual's point of view by
  - displaying his computer file
  - taking out his file and papers

  and registering the data using appropriate procedures.

* in the second case, the subjects use an "accounting" file
  - in the computer system
  - or in an accounts book

  and entering the data or updating the tables.

These particular entries belong to the different procedures where various other actions are planned such as sorting the cheques, checking them, sending them to the bank, or more rarely, sending a receipt or sending the rent to the owner (appendices E.4.3., E.4.4. and E.4.5.).

The points in common with the subjects' usual tasks are mainly located at the level of the representations that the subjects have of what makes up the work context: the tools, filing system and how the accounting is carried out. These representations determine the choice of support for registering the cheques and explain the 2 main orientations: a personalized file or general accounting file. What is in common in the representaions concerns the way the data are entered, the checks made or a file is sought.

It cannot be said that the subjects' experience directs them more towards one means of registering rather than the other. However 2 subjects registered the cheques both ways which clearly shows that both orientations form an integral part of their procedures.

5. *Make a table summarizing the tenant's accounts*

This task caused some problems for almost half the subjects who had to make several attempts (2 or more) (appendix E.5.1.).

1.1. Preparing the accounts statements

Two procedures were planned (appendix E.1.2.):

- take the statement as ready prepared by the accountant and type it
- edit and print using a personal computer.

We found some similarities to accounting procedures used by the subjects whose usual activity includes some accounting work (appendix E.1.3.).

1.2. Doing the letter

All subjects produced a standard letter-type (appendix E.1.4.) which either they already had in the computer memory or else they prepared, sometimes by modifying an existing letter.

Some particularities were found in the details that certain subjects included from their tasks: a rough draft, labels, the use of headed writing paper and a mailing list file (appendix E.1.5.).

1.3. Sending off the letter

Most of the procedures used have been described previously (Sebillotte, 1988) (appendix E.1.6.). Certain subjects added other actions to be carried out either simultaneously or subsequently. These actions can be traced to the subjects' usual activity: "reserve a room for the meeting" or " keep a copy of the letter for the proceedings or the report of the meeting".

2 . *Make a new file for someone who is coming to sign a rent contract this afternoon*

The instructions implied that 3 points should be dealt with: the file, the contract and the deposit. The expert (control subject) set 6 goals when describing the task, all of which could be implied from the instructions (appendix E.2.1.).

All of the subjects made up a cardboard file to contain the necessary papers and documents. 13 subjects prepared the contract or lease (10 using a standard contract) and a little over half of the subjects attended to the deposit and the signing of the lease (appendix E.2.2. and E.2.3.)
It is interesting to note that 10 out of 16 subjects systematically used a computer tool to enter data about "the tenant" (a description which is also present in 7 of the subjects' descriptions of their activity; all of these subjects have computer tools in their usual work environment) .

The relation between the descriptions of this task and the subjects' usual activity shows that they refer to what they already know to carry out the experimental task. As before, in the plan used by the subjects, we find other actions coming from their usual work : check off the elements of a file on a list, update the chart , make references for the files, have the same information in two different places (appendix E.2.4. and E.2.5.).

3. *Check and settle 3 invoices*

All the subjects followed the same procedure for the 3 invoices while taking into account the particularities of each. The instructions implied 2 major goals : check the invoices and settle them. The control subject does not pay the invoices herself, but sends them to the accounts department and sets 3 goals: check the invoice, transmit it to the accounts department and file the invoice once it has been dealt with by this department (appendix E.3.1.)

For the expert subject, checking an invoice involves 3 checks: the calculations, the conformity, and that the work has been done as specified in the file. For all the subjects, checking an invoice means checking its conformity, 9 only checked the calculations and 6 verified that the work had been done (appendix E.3.2.).

THE SUBJECTS' REPRESENTATIONS OF THE UNFAMILIAR TASKS

PLANNING THE FIVE PROPOSED TASKS

In the instructions, the five tasks were always given in the same order but the subjects were free to carry them out in whichever order they wished. We were able to classify the subjects in 4 groups:

- those who selected and justified a particular order: *"I'll begin/continue by ...because..."* (8 subjects and the control subject),
- those who chose a certain order but did not justify their choice (3 subjects),
- those who chose to carry out the tasks in random order: *"I'll do this one next, what is it?"* (2 subjects)
- those who carried out the tasks in the order in which they were presented in the instructions (3 subjects).

The criteria for justifying a choice were the following:

- urgency (5 times): the mail *"that must be sent off"* and the file for the person *"who is coming to sign a contract this afternoon"*,
-*"consistency and continuity"* (4 times),
- ease: *"the easiest first"* (2 times); *"leaving the most difficult till last"* (1 time).

When organizing their activity, the subjects placed particular emphasis on considerations of time (temporal imperatives) and the possibility of grouping together tasks of the same type.

In fact, leaving aside the 3 subjects who followed the order in which the instructions were given, we find that as concerns the other 13 subjects:

- 6 grouped together the 3 tasks involving accounting (register the cheques, check the invoices and make a summary of a tenant's accounts);
- 7 grouped together the tasks "send the letters for the annual meeting of the joint owners" and "prepare the file and the contract for a future tenant";
- only 2 subjects worked without grouping any of the tasks together.

The control subject and 4 of the subjects organized their work by "grouping everything to do with accounting together" and "grouping everything involving drawing up documents together".

THE REPRESENTATIONS OF EACH TASK

The subjects' representations of the unfamiliar tasks were modelled in the same way as the activity from the protocols

Each task was then analyzed using the set of models obtained for each task. Our analysis was guided by the control subject's representation. Only the main results are given below; for a more detailed account, see the appendices.

1. *Send the letter for the annual meeting of the joint owners*

The subjects were instructed to include an accounts statement. All of the subjects, as well as the control subject, adopted the general plan of preparing the statement, drawing up the letter, and sending off the letter with the statement enclosed.

* now, the subject's representation of the task has become
  - make a basic table
  - note the modifications
  - print out one or several situations : change the title,
  - duplicate as many times as necessary and dispatch the document.

We also remarked that beforehand the subject's representation of her activity was like a sequence of specific data processing (accounts commitments, legal commitments, etc.). The results were then recapitulated in the well-defined tables. On the other hand, now the type of data to be considered seems secondary, what is important is to print a precise situation which is then defined from the data as it is entered (the computations and modifications being made automatically).

" *type a thesis or scientific paper*" becomes " *make a data entry of the thesis or the paper*",
" *show legal commitments in summary tabular form and register accounts commitments*" becomes " *update accounts and legal commitments*"

This is explained later when the subjects are asked to describe these tasks. The described procedures differ because the subjects now use new equipment. The actions which the procedures consist of, influence the choice of one expression to designate the task to be carried out. We found again the strong hold of certain actions or characteristic procedures used during the carrying out of the task.

2. Comparison of the different procedures used by the same subjects to carry out a same task

We interviewed again the 6 subjects who had answered the questionnaire. They were interviewed about certain tasks whose representations might be supposed different owing to the introduction of new tools.

We asked the subjects to describe these tasks in detail and we compared the current representations with the previous ones.

From the declarative aspect, the action schema remains virtually unchanged. What differs in the representations are the procedures used to carry out certain goals . So:

-*"Type a scientific article"* for two subjects is still (appendix 4):

. type out or edit the original copy
. give for rereading and for correcting and after, make the corrections
. keep a copy
. print n copies of the article.

- *"answer the mail"* for two other subjects remains (appendix 5):

. do a letter
. register the reply
. keep a copy

But the procedural aspect is no longer the same, depending on whether the subject uses a typewriter, a text editor or a personal computer.

The same is true for other tasks, such as *"make a certificate"* (appendix 6) or *"take a charge of the budget for every budget account"* (figure 2). In this task, for example, we find:

* concerning the results of the action, the task is still the same and consists of : note data, calculate and print one or several statement table summaries , duplicate them n times and dispatch them.

* but concerning the procedures, the subject's representation is completely modified (the structure of the sub-goals and the planning of these are different), because the subject uses a personal computer and a spreadsheet.

Thus:

* when the subject worked "by hand", she described her task in the following way (we will not detail each sub-goal):
- put together data on cards according to certain criteria,
- make up the elements in tabular form: deal with every type of data, calculate and sum up in the table(s),
- photocopy and then dispatch the tables.

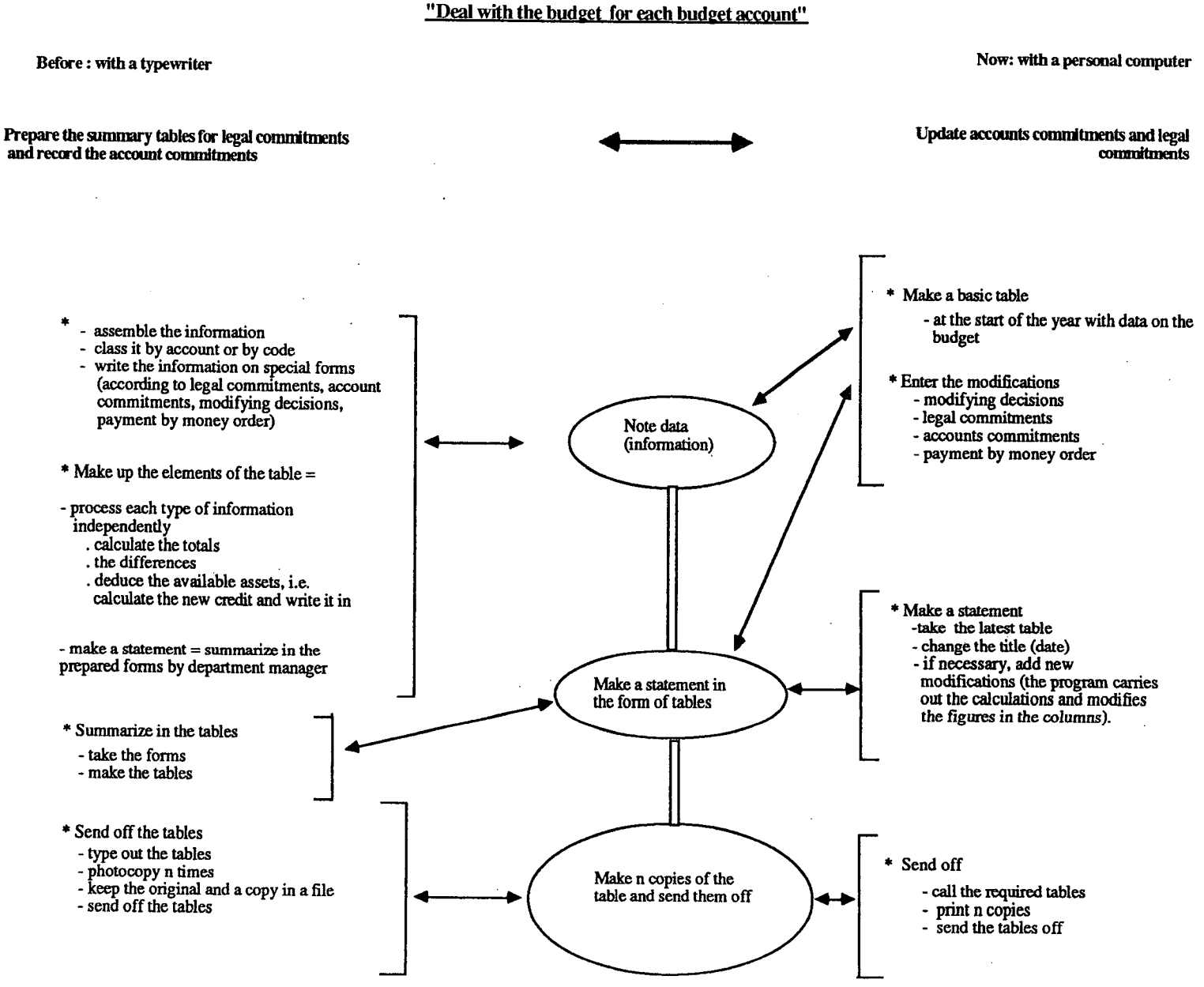

FIGURE 2: Comparison of the procedures used by a subject to carry out the same task.

THE SUBJECTS' REPRESENTATION OF THE USUAL ACTIVITY

ACTIVITY REPRESENTATIONS : SPONTANEOUS LEVEL OF ABSTRACTION

In the previous study, we showed that the subjects' representations of their activity were hierarchical. The subjects listed a set of tasks or sub-tasks which they subsequently detailed. However, we could class the subjects in 3 categories, according to the way in which they explained their activity:

- the subjects who gave hierarchical descriptions spontaneously i.e from an abstract formulation of their task, set intermediate goals and sub-goals before giving a detailed description;
- those who gave hierarchical descriptions, but only provided details when asked "How ?";
- only 2 subjects (out of 14) listed action sequences which all seemed at the same level.

The 10 new subjects were classed in the same way and the results were: (figure 1)

- 5 subjects presented their activity as a clearly precise function to be fulfilled : for example "I am the secretary of the Director of X.." or "I am the *"ticket dispenser"* , which was said before listing their main tasks (task formulation = the most abstract level for a given task) as the 10 interviewed subjects did;
- 8 subjects detailed their tasks with sub-tasks (2nd level) and one detailed a little more than the 2nd level (3rd level).

Representing their activity by a function to fulfil does not mean that subjects have only a global representation of their activity. Their representation is hierarchical since they spontaneously detail this representation up to 1, 2 or even 3 levels, as the example shows (appendix 3). This confirms our previous results.

EVOLUTION OF REPRESENTATIONS OVER TIME

1. Answers to the questionnaire

The 6 "old" subjects had to answer 4 questions :

- Do you still work in the same department ?
- If "yes", have there been any changes (reorganization, new equipment)?
- If "no"', does your new work seem different from your previous work?
- What does your work consist of ? List the main tasks which you have to carry out.

Among the 6 subjects, one of them does not work in the same department. All say that the main change is the introduction of new equipement: in particular personal computers (for 6 subjects) and sophisticated text editors for 3 subjects).[1]

Compared with the previous study, we found some differences in tasks listing, deletions of some tasks and the occurrence of some new tasks. This is due to the normal evolution of departments whose aims vary.

Concerning the same tasks or considered as such because the same goal must be carried out, it is interesting to notice that the subjects have different representations and for this reason designate the task differently:

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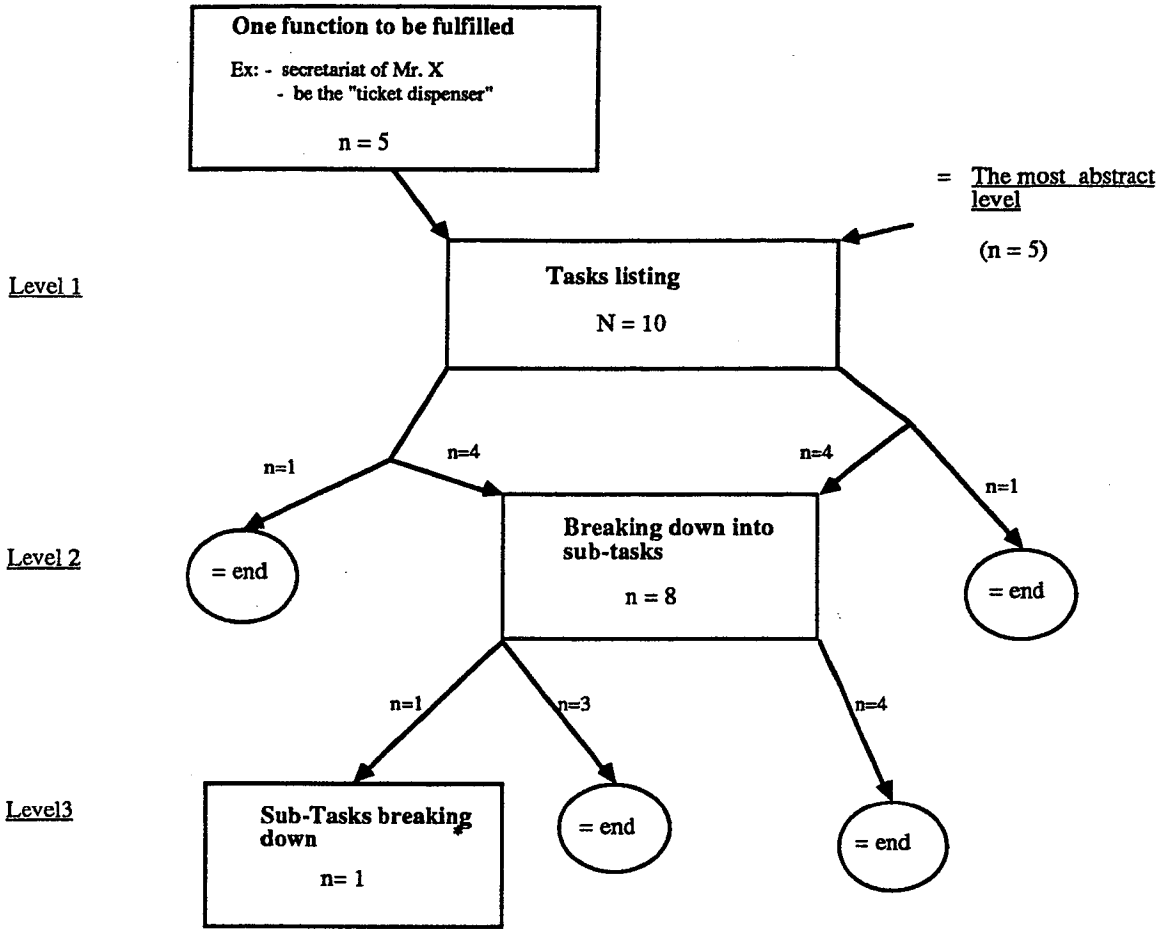
[1] Generally speaking, the subjects find that the introduction of this new equipment has made their work more pleasant and less repetitive.



* The subject will detail this level later during the interview

FIGURE 1: Abstract Levels of spontaneous representations of activity for 10 subjects

The experimenter always answered questions about procedures to carry out a task in the affirmative. For example, for the questions "Do I make a copy? Do I keep the original? Do I transmit or class it? etc." the answer was always "Yes, if you think so" . The aim was to set minimal constraints.
For information concerning the tasks themselves, a set of systematic answers were anticipated or if an answer had not been anticipated, the experimenter answered as well as possible and noted it thereby increasing the body of possible answers.

The subjects had pencils and paper at their disposal, and explained aloud how they intended to carry out the task. Each protocol was fully tape-recorded and transcribed .

FORMALIZATIONS AND ANALYSES

1. Tasks formalization

From the protocols, each task described by the subjects was modelled as a hierarchical plan using the same method as in the previous research study (Sebillotte, 1988).

2. Analyses of activity representations

Concerning the subjects' representations of their activity, we analysed :

- on the one hand, the part of interview when the subjects talked freely, in order to find the different levels of abstraction that the subjects have when they talk about their activity;
- on the other hand, for the old subjects, the relationships between their new and old representations for the same tasks.

3. Analyses of the experiment

We made two analyses:

- a global analysis of the set of subjects' representations for each task proposed;
- for each subject, the relationships between the representations of the proposed tasks and one or several tasks which she usually carries out and she had described.

Each interview and the explanations that each subject gave were tape-recorded and subsequently transcribed.[2]

EXPERIMENT

The aim of the experiment was to put the subjects in an unusual work situation and to analyze how they represented the tasks to be carried out, in order to compare these representations with the representation of their work obtained from the interviews. The hypothesis to be tested was that whenever possible, the subjects would use action schemata which they knew to carry out the new tasks.

All of the subjects (i.e. 16 old or new subjects) took part in the experiment.

1. The unusual situation and the tasks to be carried out.

In order to put the subject in an unusual situation, we imagined and suggested a work context which differed from their usual work context. The context that we chose was an estate agency such as is specified in the instructions (appendix 2).
In order to be able to compare the representations, we had to present the subjects with tasks which were unfamiliar but which were nonetheless quite close to their usual tasks.

We fixed ourselves two constraints:

- It had to be possible to recall certain schemata from memory.
- At least one of the tasks proposed had to appear to be close to one of the tasks described by the suject.

The tasks were selected in the hope that the subjects would use (to carry out them):

- either common procedures such as sending a letter or notification or document, recording or checking something, making a file;
- or sub-goals at higher level (Sebillotte, 1988) such as making a summary or drawing up a contract.

Finally, we suggested 5 urgent tasks for the subjects to carry out:

- to register 3 cheques which had arrived that morning,
- to send letters to the persons concerned for the annual meeting of the joint owners of the apartment block at *"6 rue des Violins"*,
- to prepare a new file for *"Mademoiselle Guitar"* who was to sign a rent contract that afternoon,
- to make a accounts table summary for *"Monsieur Piper"* who was to leave his apartment and return the keys the next day,
- to verify and settle 3 invoices received the day before.

2. Procedure

The subjects took part in the experiment at least 3 weeks after the interviews .

A subject who works in an estate agency also took part as a control subject in order to provide task descriptions as a point of reference.

After having described the situation and listed the tasks to be carried out, we gave a stack of five small files corresponding to each task. The subjects found the necessary information (written on a card) or documents (cheques or invoices). The files were always presented in the same order, but the subjects were free to proceed as they wished.

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[2] The transcription of the tape-recordings was carried out by M.P. Laborne.

METHOD

Two main parts should be considered in this study:

- the representations of tasks which the subjects usually carry out in their professional activity, which were obtained through interviews and by certain subjects answering a questionnaire .
- the representations of experimental tasks, with which the subjects are unfamiliar .

THE SUBJECTS

The 16 female subjects (secretaries or office workers) who participated in the experiment, work in a Research Institute.
Although half of them work in administrative departments and the other half work in research departments, they were all used to carrying out administrative tasks.

The set of subjects was made up of 2 groups:

- one group of "old" subjects: 6 subjects who had taken part in a previous study (Sebillotte 1988). Their usual tasks had already been formalized as the subjects'representations 3 years earlier.
- one group of "new" sujects: 10 subjects who had never participated in our studies.

THE QUESTIONNAIRE AND THE INTERVIEWS

1. The questionnaire

The questionnaire was for the subjects who had taken part in the previous study and aimed at establishing which changes had occurred in their global activity over the three years. The changes may involve the introduction of new equipment, reorganization of the department, a new workplace or new tasks to carry out.

2. The interviews

Each interview and the explanations that each subject gave were tape-recorded and subsequently transcribed. The way the interviews were directed depended on whether the subjects were "new" or "old"

* *new subjects*[1]

The interviews consisted of 2 parts: one free and the other semi-directed. The parts progressed in the following way:

- firstly we asked each subject about her work and we did not interrupt her until she stopped. All her explanations were tape-recorded. The aim of this part was to discover the level of abstraction at which the subject's representation was given spontaneously.
- when the subject had finished speaking, she was asked if she had anything futher to add;
- only when the subject had nothing more to say , did we ask her to specify the main tasks she had mentioned (semi-directed interview). This was done using the method developed by Graesser (1978 and Graesser et al. 1981) which we had used beforehand.

* *old subjects*

The interviews only concerned changes that had taken place since the last interviews and the new tasks that were noted in the answers to the questionnaire.

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[1] The subjects were interviewed by J.F.Forsy, who conducted a large part of the experiment.

We propose here to systematically highlight action schemata in work situations. These action schemata are the schemata which the subjects call when they must carry out tasks.

THE AIM OF THE RESEARCH

From the axiom that knowledge consists of schemata in memory which are used when it is necessary (for example to execute a similar task, to solve a problem analogous to a known problem or to build new schemata), the goal of this research is to show and describe action schemata, their building and their use in a particular work context.

In a previous study, Sebillotte (1988) showed that the subject's activity representations are hierarchical (in the sense of hierarchical planning developed in Artificial Intelligence).

In these representations of expert subjects, we can distinguish four main levels:
- the most abstract level or the task formulation,
- the expert level which represents specific context procedures (or sub-tasks),
- the highest common level, these are the common procedures which are domain-independent and may be considered as more general elements of knowledge,
- the lowest explicitable level or elementary actions.

This study is based on the analysis of specific tasks that the subjects usually carried out in their work.
Now, we propose to try to highlight in these subjects' representations, what we will call "action schemata", defined according to Bobrow and Norman (1975) as " active processing elements which can be actived from higher level purposes and expectations or from imput data which must be accounted for ". In other words, what subjects extracted from their activity knowledge, stored in memory, and used when in an unfamiliar situation. Subjects may run the risk of applying an inappropiate schema, as has been suggested by Rumelhart and Norman (1981).

To identify these schemata which are in memory and used by the subjects in a given situation, our method consisted mainly of the subjects participating in an experiment where they had to carry out a set of tasks in an unfamiliar context. The representations of these experimental tasks were compared with the representations of usual tasks which the subjects had described beforehand.

schemata permit them to recognize objects, to make judgments, to understand stories and to act in the world. They serve to extract and categorize clusters of experiences from everyday life. A script should be a particular type of schema that corresponds to conventional or frequent actions in a particular situation (Graesser et al., 1980)

* *A hierarchical structure*

Schemata are organized hierarchically according to a part structure (one schema can occur as part of another, just as a window schema is a part of a wall schema). The whole schema may be necessary to invoke only a part of the schema but a part schema may also invoke the whole schema.

Among the criticisms of schema theory, we will emphasize one made by Anderson (1983). Anderson contrasted production systems with those systems having a schema architecture (schemata, frames, scripts etc...) and his main criticism is :

1) schema theory blurs the procedural-declarative distinction and leaves unexplained the contrast between procedural and declarative knowledge;
2) the knowledge units tend to be too large and the size of schemata makes it difficult to construct effective theories about their acquisition. On this point, Rumelhart & Norman (1981) have proposed that new schemata could be created by modeling them on existing schemata and modifying them slightly.

ACTION SCHEMATA AND THEIR PROCESSING

According to Richard (1988), an action schema (the way of representing the knowledge about the action stored in memory) contains information about the result of the action, the different ways this result may be obtained and the prerequisites implied by each of them.

Richard considers that knowledge about action takes the form of schemata in which information is stored at three levels: the result of the action, the processes (one or more) allowing the result to be obtained, and the prerequisites of each process (enabling conditions and associate actions).

He assumes the information in the schema to be accessed in that order and so there are three ways of processing the information:

- processing the result or goal alone (most frequent in understanding stories)
- processing the goal and the procedure (sometimes necessary in understanding stories)
- processing the goal, the processes and the prerequisites of the process (necessary when we have to carry out the action.) This case implies that a planning process is necessary to interpret the schema and take into account the sequence of actions to be done in the actual context of the action.

Richard gives and analyzes several instances. These instances show two of the most representative ways of explaining the knowledge about an action.

- reading the information of the schema in memory corresponding to this action (i.e. to directly express the goal, processes and constraints of the action),

- interpreting the content of the schema by a planning process (i.e. to express the actions which compose the activity , in the order in which they are carried out).

To emphasize his point of view, Richard considers how action schemata are processed in three kinds of task: the execution of instructions, the comprehension of written narratives, and the expression and elaboration of procedures.

sequence of events in a particular context. This hypothetical structure, when activated, organizes the comprehension of event-based situations. The notion of plans is introduced to account for the deliberate behaviour that people exhibit from general knowledge about the new situations.

The notion of schema has mainly been used for the understanding of texts (Rumelhart and Norman, Schank and Abelson). In Artificial Intelligence, planning processes are based on it (Sacerdoti, 1977). The studies of Brewer on memory (recall and recognition of goal-directed events or actions highlighted the use of plan schemata. (Brewer et al. 1980, 1981 and 1983).

Schema theory is basically a theory about knowledge. It is a theory about how knowledge is represented and about how that representation facilitates the use of knowledge in particular ways. All knowledge is packaged into units or blocks. These units are schemata and have the following characteristics:

* *A data structure*

A schema is a data structure for representing the generic concepts stored in memory. It is a somewhat general description, providing only the skeleton around which the situation is interpreted. The schema is then instantiated. There is a instantiation of a schema "whenever a particular configuration of values are bound to a particular configuration of variables at a particular moment in time" (Rumelhart, 1978).

* *A configuration of sub-schemata*

A schema should be viewed as consisting of a configuration of sub-schemata corresponding to the constituents of the concept being represented. Among the major features , we emphasize that schemata can be embedded, one within another; they represent knowledge at all levels of abstraction and play a central role in all of our reasoning processes.

Rumelhart and Norman (1978) argue that memory contains a record of our experience. Some of the information is particular to the situation that it represents, whereas other information is more general, representing the abstraction of the knowledge of particular situations to a class of situations . General information should be better represented in schemata than more specific information. The schemata are the meaning and processing units of the human information-processing system.

* *An active knowledge structure*

Schemata are active interrelated knowledge structures. They contain variables. Our representations for specific events are thus instantiations of the general schema for that event type.
A schema can represent an entire situation, showing the interrelationships between component events or situations (or sub-schemata). When a schema is sufficiently poor at describing the situation, a new schema must be sought. If no single adequate schema can be found, the situation can only be understood as a set of disconnected sub-situations and each sub-situation interpreted in terms of a separate schema.

Anderson (1980) distinguished a schema from a prototype. These two terms are often interchangeably used. For the author, a prototype is like an instance in that it has all values filled in, while in a schema some values may be omitted. A prototype should be a construct example of a hypothetical and most typical instance of a category. A schema should be a construct composed of an often incomplete set of features that frequently occur together in the category. The term schema is thus used to refer to collections of feature sets and differs from a prototype in that not all of the features need to be specified.

Schemata are important knowledge structures which consist of many known characteristics about general categories of objects, classes of events and types of people. Humans are adept at detecting correlations between events and building schemata to embody these correlations. Such

INTRODUCTION

Knowledge about actions would appear to be kept in memory in the form of action schemata, the same action schemata being used for different tasks (understanding a narrative or an operating instruction or learning new procedures). It is only the processing of these schemata that differs (Richard, 1986).

In a new paper, Sage (1987) discusses issues relevant to the design of systems, in particular computer-aided systems for knowledge-based support of humans in purposeful activities involving judgment and choice. In this paper he focuses on the way in which human knowledge may be represented in such systems.

He emphasizes that schema theory argues the prevalence of decisions based on recognizing that a situation corresponds to a particular schema . This is as true for system design as for explaining certain observed behaviour. But when situations are ambiguous and correspond to several schemata or when a situation is not very familiar to the subject because he has not experienced it and which does not suggest any schemata, then alternative methods are used to make a decision.

In his paper, Sage sets out several types of representation and underlines that it is especially necessary that a knowledge representation schema be capable of coping with the types of expertise and the reasoning perspectives that can be expected to exist among the users of the knowledge-based system.

To design systems and to satisfy the requirements mentioned above, the question arises as to which schemata the future users have and how they are used.
This paper presents one study that aims at answering, at least in part, this question, but first we will define what we call a "schema" and will emphasize what is particularly important for this study in schema theory.

THE SCHEMATA AND THE SCHEMA THEORY

Many representations are based on schemata: whether they be in psychology concerning cognitive development, knowledge acquisition and learning, problem solving etc., or in Artificial Intelligence and systems design.

Schemata, frames, scripts, plans, etc. are various terms which have been used by different authors to refer to any of set of interrelated concepts. These terms however are not all synonymous.

The concept of schema which we will use here is one developed by Rumelhart (1978): Schemata are " Building Blocks of cognition". They are the fundamental elements upon which all information processing depends. They are used in the process of interpreting sensory data, in retrieving information from memory, in organizing actions, in determining goals and subgoals, in allocating resources and generally in guiding the flow of processing in a system, etc.

A "frame" used by Minsky (1975) refers to a knowledge representation structure concerning very limited domains. A frame provides a description of the object or the action. At first, there is an invariant structure which is common for all cases. Some characteristics are added to this structure according to particular observations.

The concept of "script" was introduced by Schank and Abelson (1977) to account for knowledge about mundane situations . It is a cognitive structure that describes an appropriate

SUMMARY

Abstract

The aim of this study was to describe action schemata that have been acquired through experience and to study their use and the way in which they are adapted. Our hypothesis is that these schemata will be used when the work situation changes (new conditions of work or when faced with unfamiliar task). 16 subjects (secretaries or office workers) took part in an experiment: firstly, they were interviewed about their activity, and then they had to carry out certain tasks in an unfamiliar context. The comparison between the subjects' representations in the two situations (professional context as opposed to unusual context) allowed the description of the action schemata.
The results obtained confirm our hypothesis and agree with schema theory: schema instantiation, creating new schemata by modifying an existing schema or building a new schema from more elementary ones.
Various results emphasize the importance of distinguishing between declarative and procedural aspects for task representation and interface design.

Key-words : Schema, Knowledge representation, Schema theory, Task analysis, Planning, Procedures.

Résumé

L'étude vise à mettre en évidence l'existence de schémas d'action acquis par l'expérience au cours d'activités professionnelles et à en étudier les modes d'utilisation et d'adaptation. On fait l'hypothèse que l'on devrait retrouver ces schémas d'action quand il y a des changements de situation (nouvelles conditions de travail ou confrontation à une tâche inhabituelle). Après avoir expliqué leur activité, 16 sujets (secrétaires ou personnels administratifs) ont participé à une épreuve expérimentale au cours de laquelle il leur était proposé de réaliser 5 tâches "inhabituelles". Les schémas d'action ont été mis en évidence en comparant les représentations des sujet dans les deux situations (activité professionnelle et contexte inhabituel).
Les résultats confirment l'hypothèse et sont en accord avec la théorie des schémas: instanciation de schémas connu, création de nouveaux schémas à partir de schémas plus élémentaires.
Différents résultats mettent l'accent sur la nécessaire distinction dans les schémas d'action entre ce qui est déclaratif et procédural, pour représenter des tâches ou pour la conception d'interfaces.

Acknowledgements

We wish, in particular, to thank the sixteen persons from the Institute who agreed to take part in this study for their good-natured cooperation, as well as Monique Thibaud who accepted to serve as the control subject.
We should also like to thank J.F. Forzy who conducted a large part of the experiment and the interviews, M.P. Laborne who transcribed the recordings and K. James for his help with translation.

ACTION SCHEMATA IN PROFESSIONAL ACTIVITIES

The use of existing schemata and their role in the construction of new schemata in the context of administrative tasks

LES SCHEMAS D'ACTION DANS DES ACTIVITES PROFESSIONNELLES

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Suzanne SEBILLOTTE

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